ENGINEERING PPT7

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STAND EASY

THERE is no peace for engineers. They must grasp the significance of the latest developments in engineering even if they don't understand them. An article on exhibits at the Instruments, Electronics and Automation Exhibition which opens in London on May 7 will appear in a later issue of ENGINEERING. But meanwhile, for visitor and non-visitor alike, an appropriate attitude of mind may usefully be suggested.

The exhibition is a shop window for the components of a programme of instrumentation or automation. By their very nature the components to be displayed are not necessarily of immediate application to the needs of an individual firm. A design engineer might see radio-isotopes on one stand and electronic pulse counters on another. Neither may be of immediate use to him and he may possibly give them only brief consideration. However, such devices in combination may provide just the thickness measuring gauge he requires. This example is well known and many firms already offer such thickness gauges complete. But in many more instances it is true to say that an instrument or electronics firm produces an item of equipment that has so many applications—both known and unknown to its manufacturer—that it is difficult for the firm in question to know what, and to whom, to publicise.

The situations that frequently arise vary from that in which a device is manufactured to the specification of a firm in order to fulfil a specific application, and later finds a totally different application in an unrelated field, to the situation where a firm produces a device that exploits a new or hitherto neglected physical principle and then is at a loss to know what to use it for. It is in such circumstances that an exhibition such as the I.E.A.E. can be of the greatest value. But whether the potentialities are realised depends on the presence of a dynamic outlook on the part of both visitor and exhibitor. And it is on the former that the burden of responsibility rests.

A representative of a mechanical engineering firm may justifiably complain that the great majority of the devices at the exhibition are electronic, and as such are as much a mystery to him as his machines are to the electronic engineer. The implication is that communication is not possible between specialised fields of work and that specialists should confine themselves to exhibitions of their own specialist equipment. Such defeatism leads to the sort of frustrating situation mentioned earlier, and prevents much mutual assistance that may be derived by one specialist from another. Yet how is the barrier of high-grade ignorance to be surmounted? The visitor representing a firm must be able to look at his firm with new eyes. The specialised needs of his firm must be translated into a more general statement. It is not necessary for the specialist jargon of one field to be translated into the specialist jargon of another—the process is tedious, limited in scope, and lacks an important by-product of the suggested procedure of translating into a more general statement. For often a reconsideration of a production line in more general terms will immediately suggest improvements that can be made before the skill of other fields is enlisted. In one case a firm decided to use electronic accounting techniques, and in the course of assessing the change-over problem they discovered that the work could have been done with a quarter of the staff and no electronics at all.

Thus the visitor to the exhibition should be ready to consider techniques and devices that at first glance might appear to be unrelated to his needs. An example has been mentioned of a counting device used for measuring a linear dimension. Other examples are readily available—perhaps the technique of evaluating wear in engines, by measuring the increase in radioactivity in engine oil, might be adapted to determine the efficiency with which a machine washes and rinses clothes. By translating the statement that the movement of abraded metal in oil can be followed by radioactive techniques, into the more general statement that the movement, or lack of movement, of one medium in another can be detected by such techniques, we achieve the transition from engine to washing machine.

A stumbling block to the realisation of the possibilities of equipment is, however, often provided by the exhibitors themselves. In attempting to attract the idle eye the designers of stands in exhibitions too often sacrifice logic to novelty. A display can be attractively designed and still convey the more general implications of a particular piece of equipment. It is to be hoped that the 200 manufacturers at the forthcoming exhibition will succeed in producing such displays.

The visitor will only have a limited amount of time to study any one stand—not because of unnatural impatience but because of the very size of the exhibition—and so a display must put its message across quickly and clearly. The exhibition browser, fresh from a morning in the open, where he has been watching, perhaps, a hole being dug in some neighbouring thoroughfare, will no doubt happily ruminate for an hour or so before a busy display of coloured lights and polished walnut veneer, but his presence will be of little value to the exhibitor. The man who

matters to the exhibitor is every bit as human, and just as easily attracted by the art of display, but the stands must help him in his difficult task of reaching the heart of the matter quickly.

* * *

Plain Words

When Lord Heyworth, chairman of Unilever Limited, gave the Stamp Memorial Lecture last November on "The Control Centre for an International Business" he had much to say about the taxation of salaries. He made a comparison among 11 countries of the burden of taxation on executives' salaries. This is a problem which is particularly urgent for companies with international ramifications for it is virtually impossible to transfer a man from an area of low taxation to one of high taxation when variations in the burden of taxation between different countries are as large as they are to-day.

It is a question of some interest as to whether the Chancellor of the Exchequer's gestures to surtax payers in the last Budget have effected the international comparison between net earnings. Before the Budget, out of the 11 countries taken, Norway had the steepest rate of taxation up to £40,000 a year, while Sweden and the Netherlands took second and third place respectively up to £4,500 a year. The United Kingdom moved up from fourth to second place beyond £4,500 and eventually took over the lead at £40,000. At the other end of the scale France and the United States showed the slowest rate of increase in taxation on high incomes.

Mr. Thorneycroft's concessions have made quite a significant difference to the picture of salaries up to £10,000 a year. Up to that level the burden of taxation is higher now in Norway, Sweden, the Netherlands and New Zealand than in the United Kingdom. The burden is higher in Germany than in the United Kingdom for salaries up to £5,000 a year. The reduction in burden offered by the Chancellor last month still left the United Kingdom surtax payer worse off, however, compared with seven other countries between £5,000 and £10,000 a year. The incentive given in the Budget is thus of very limited value for an international organisation which might want to move top level executives from, say, the United States or Canada to the United Kingdom, and the position would be even worse if the man to be transferred did not have a wife and family. The good man eligible for international transfer is now probably a little more mobile measured in terms of earnings after taxation: the man at the top is not affected to any significant extent. For him the United States and the Dominions are still a much more attractive proposition if he puts his net income first than if he worked in this country. The brillant engineer may be tempted to cross the Atlantic in his youth. He is still not unduly tempted to make the return journey in early middle age.

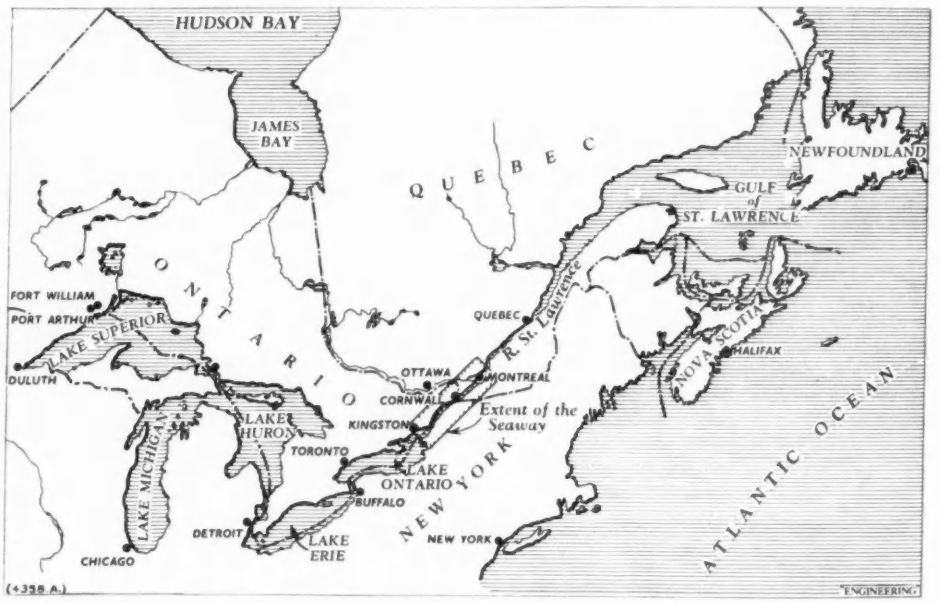
THE ST. LAWRENCE SEAWAY

STRAIGHT TO THE HEART OF NORTH AMERICA

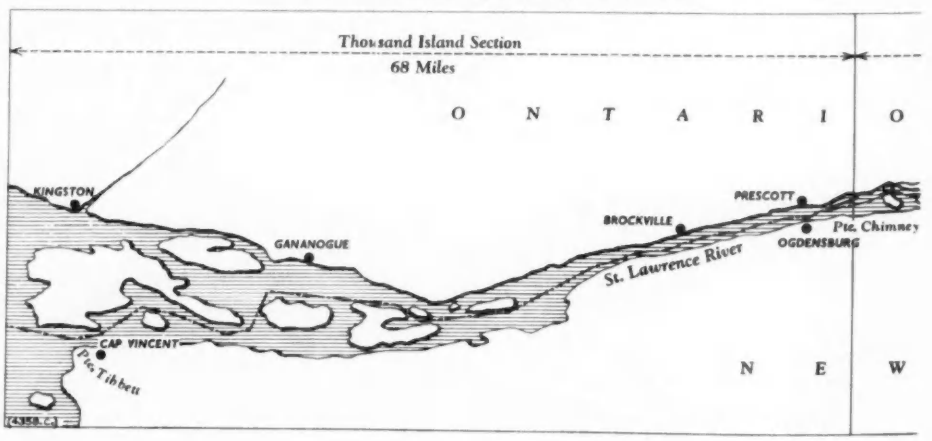
Before the opening of the navigation season in 1959, the St. Lawrence Seaway, for half a century the subject of intense study and fierce controversy, will be finally ready to receive shipping and the great power project, harnessing the waters of the International Rapids section of the river, will begin generating current for the Province of Ontario and the State of New York. By the end of last year, on the Canadian side alone, over 26 million cubic yards of channel had been excavated, representing 51 per cent. of the work to be done, and a further 6¾ million cubic yards had been dredged, representing 37 per cent. of the total required. Of the estimated total of 2,010,000 cubic yards of concrete, 400,362 had been placed and ten new bridges were under construction with three more to come. Construction and equipment contracts placed by the St. Lawrence Seaway Authority have been awarded to a total of about 200 million dols., or nearly 90 per cent. of the total estimated cost of the project.

The works include a 10 mile canal in the Lachine section which extends from the Harbour of Montreal to the head of Lake St. Louis with a drop in water level of 50 ft.; an 18 mile stretch in the Soulanges section with a total fall of some 82 ft., involving the by-passing of existing power installations at the existing end of the Beauharnois Power Canal; and dredging of shoal areas over the 26 mile Lake St. Francis section where the river widens into an area of about 90 square miles.

The main American works, to the value of about half that on the Canadian side, are being carried out by the Saint-Lawrence Development Corporation in the International Rapids section where it is building a canal and two locks to by-pass the main dam and power houses of the power project. The Seaway Authority is building a lock and canal on Canadian territory at Iroquois. This section, extending for 47 miles from the western end of Lake St. Francis to Chimney Point, four miles east of Prescott, Ontario, with a total fall in water level of 92 ft., contains the dams and reservoirs under construction by the Hydro-Electric Power Commission of Ontario and the Power Authority of the State of New York. The main gravity dam, containing the power houses, stretches from the Canadian bank just west of Cornwall to the eastern end of Barnhart Island, and will have a maximum height of approximately 162 ft. above the foundation and an overall length of 3,300 ft. Power will be generated by 32 generating units, 16 in the plants of each authority, of the modified outdoor type, without superstructure over the generating rooms. The total capacity of this project is 1,640,000 kW, with an expected average annual output in excess of 12,000 million kWh. The 16 turbines and their control mechanism on the Canadian side are



The St. Lawrence Seaway in relation to the Great Lakes and the eastern seaboard of Canada and the United States. The Seaway cuts right through the heart of industrial North America, where the bulk of the manufacturing capacity is located.

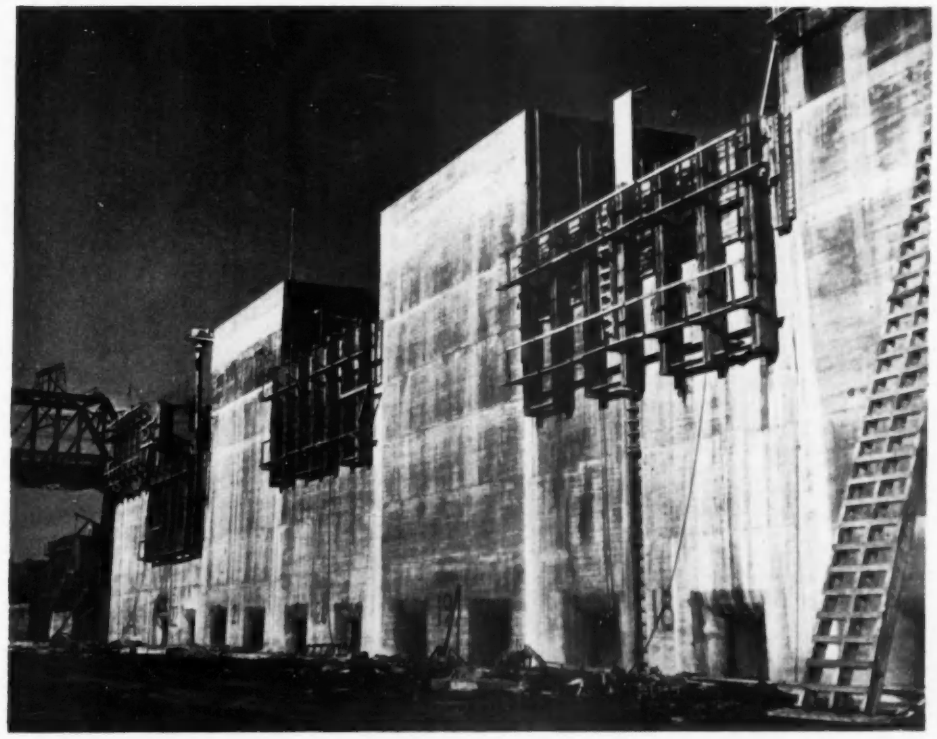


being made by the English Electric Company of Canada Limited; of the generators, half are being made by the Canadian General Electric Company Limited and half by the Canadian Westinghouse Company. A considerable part of the general construction work, including the removal and rehabilitation of four displaced towns, has been completed. The New York Power Authority has completed over 50 per cent. of the structure of the generating station and has over 50 per cent. of the mechanical and electrical equipment delivered or in progress in manufacturers' works. Ontario Hydro has completed about 35 per cent. of the work on its side. This year's programme calls for completing the concreting of the powerhouse, completing dykes, moving the remaining people in the affected area to new homes, and clearing the land which is to be flooded of trees and buildings.

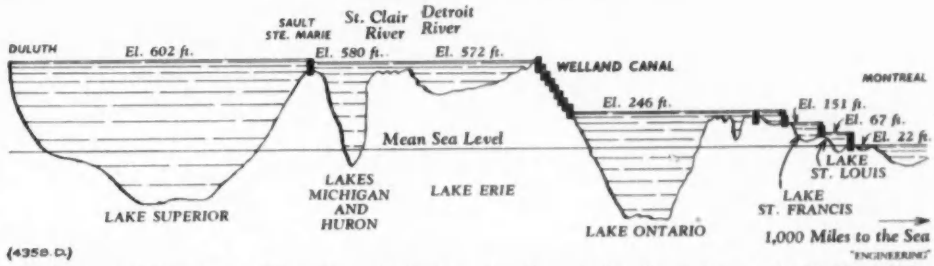
These are considerable achievements when it is remembered that the green light for the construction of the Seaway was only given finally in June, 1954, when the last obstacle was removed by the decision of the United States Supreme Court upholding the right of the Power Authority of the State of New York to build the United States phase of the power project. This was the culmination of half a century of discussion about the development of a waterway which has always played a dominant role in Canadian history since the days when Jacques Cartier, the discoverer of the St. Lawrence, was turned back by the Lachine Rapids in his attempt to find a Northwest Passage to the East. Since that time, many improvements on the river have taken place so that to-day ships of draught up to 14 ft. can pass from the Atlantic Ocean to the Great Lakes. This restricts the size of ships to those with a maximum capacity of about 3,000 tons and it is to expand this to over 10,000 tons, by providing a minimum channel 27 ft. deep and capable of handling vessels up to 765 ft. long with beam measurements of up to 75 ft., that the present works are being undertaken.

Although the idea of the improvement of the St. Lawrence for navigation purposes has been almost continuously discussed since the early Eighteenth Century, the proposal for a combined power and navigation development originated in 1919 in the United States Congress. In 1921 the subject was reported on by the International Joint Commision, comprising three Canadians and three United States members, which had been set up under the Boundary Waters Treaty of 1909, and recommendations made for a treaty for the improvement of the river from Lake Ontario to Montreal. A Joint Board of Engineers reported on the engineering aspects of the plan in 1926 and considerable interest was aroused in Canada in the succeeding years, although it was generally recognised that Canada could not undertake it by herself. Not until June 1932, did the two countries sign the Great Lakes Waterway Treaty incorporating the recommendation of the International Joint Commission, but this was not ratified by the United States Congress and it lapsed automatically in 1935.

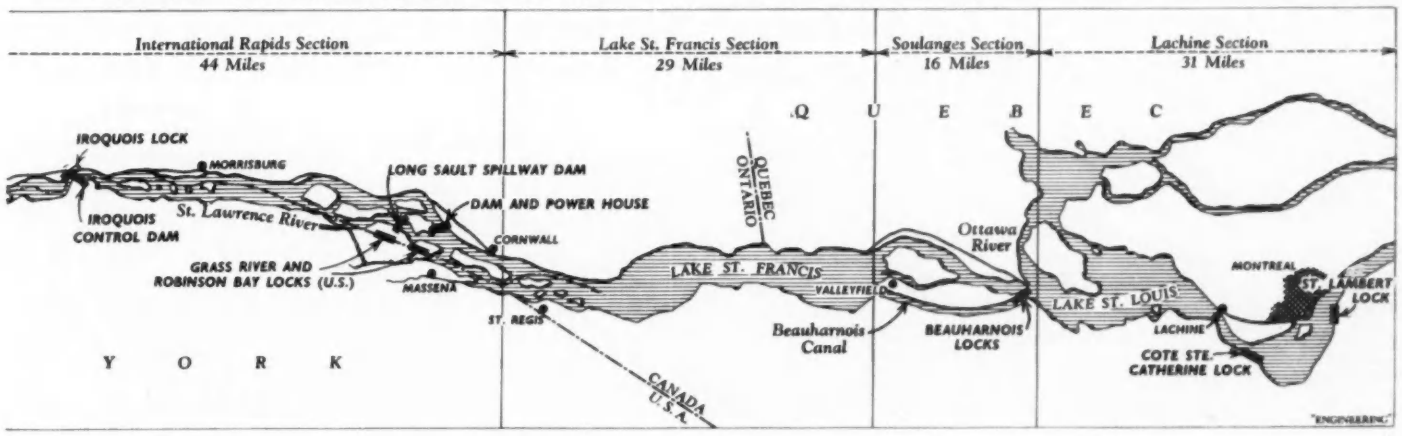
Owing to the slump this was not a propitious time for the starting of such an ambitious project and it was not until 1941 that a further attempt was made; an agreement was then signed for the Development of Navigation and Power in the Great Lakes—St. Lawrence Basin. This agreement involved collateral agreements by Canada with the Province of Ontario and by the United States with the State of New York Power Authority with respect to the cost of, and administration of, the power potentialities in the International Rapids section. These agreements aroused strong opposition from commercial and industrial interests in the United States who thought they would be adversely affected by the new Seaway and in 1951 Canada proposed to utilise the machinery provided by the Boundary Waters Treaty and tried to persuade the United States Government to join in supporting concurrent applications to the International Joint Commission by the Hydro-Electric Power Commission of Ontario and the New York State



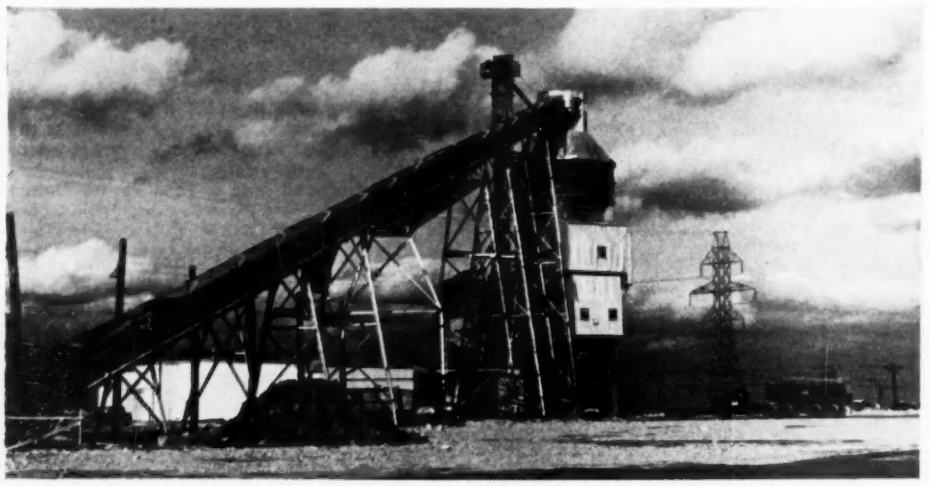
Part of the southern wall of the St. Lambert Lock now being built just upstream from the Victoria Bridge, near Montreal. It will be the first lock on the Seaway for vessels coming up river. The lift through the lock will be about 15 ft.



(Above) Longitudinal section through the Great Lakes, the Welland Ship Canal and the Seaway. Completion of the work will open up a deep-water route 2,200 miles long from the tideway and across the Great Lakes.



(Below) The principal sections of the Seaway. Besides providing a navigable route from Montreal to the Great Lakes, power will be generated for the Province of Ontario and the State of New York.



Concrete batching plant for the Lower Beauharnois Lock at Melocheville, Quebec. Construction and equipment contracts for the St. Lawrence Seaway and power project amount to more than 200 million dollars.

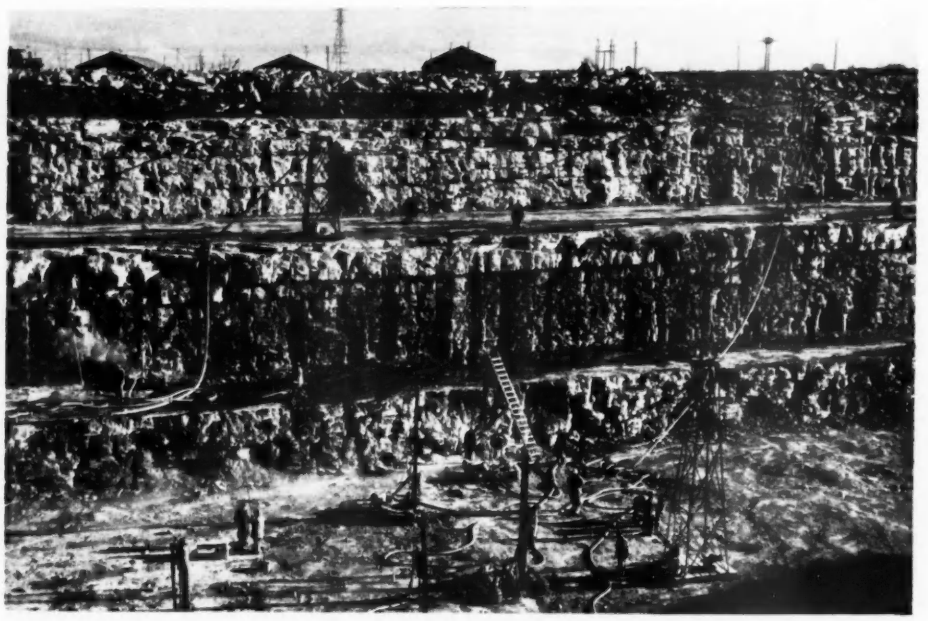
Power Authority for the prior development of the power potentialities in the International Rapids section. This was to overcome the political difficulties arising out of the federal constitution of the governments of the two countries, under which power development is a provincial or state responsibility, while the control of the waterway, which is an international boundary, is a federal matter.

The joint application to the international Joint Commission finally took place early in 1952, but by that time Canada's economic position had greatly improved and her intention to build the Seaway herself if necessary had been made clear by the re-enactment in 1951 of legislation for the establishment of the St. Lawrence Seaway.

On October 29, the Commission announced its approval of the applications and, eventually, in July, 1953, the United States Federal Power Commission granted the New York State Power Authority a licence to develop its part of the project; although this decision did not become operative until a number of appeals against it had been heard and the Supreme Court had upheld it. It was not, however, until 1954 that the authorities on the two banks of the river were able to commence their great partnership in both the power and navigation improvements; since then there has been the fullest co-operation between them.

The completion of the whole programme of works will make it possible for ocean-going vessels to sail inland from Montreal to such important lake points as Toronto, Hamilton, Buffalo, Cleveland and Toledo; and eventually there will be access to Detroit, Chicago, and the lakehead ports of Duluth, Superior, Fort William and Port Arthur. This 1,200 mile Seaway, when combined with the 1,000 mile route from Montreal to tidewater, will provide a deep water inland transport system for a distance equivalent to a sea voyage, following normal trade routes, from Copenhagen to Lisbon.

The importance of the Seaway lies in the fact that it cuts right through the heart of industrial North America: over 60 per cent. of the Canadian population is located in the provinces of Ontario and Quebec adjoining the Seaway and they account for nearly 80 per cent. of Canada's manufacturing capacity. On the United States side, the eight states adjoining the Seaway contain 35 per cent. of that country's population and contribute over a half of the value of manufacturing output. The Seaway, as a whole, will be open to navigation for some seven months of the year. At present, the river is mainly used for the carriage of bulk items, chiefly grain from the Lakes, which is then shipped at various points into small canal barges to carry it to Montreal or the ocean ports. The water voyage of grain from the Lakehead to the Toronto area, a distance of 900 miles, costs approximately 8 cents a bushel, while transport by rail or canaller, a further 300 miles to the ocean, doubles this cost. It is expected that the through movement of grain by large efficient vessels will speed up the process and decrease the total shipping cost by from 3 to 5 cents per bushel.



Excavating for the Lower Beauharnois Lock through the Potsdam sandstone, said to be the hardest rock encountered anywhere along the Seaway route.

On the return journey there will be a substantial expansion of iron-ore movement as the rapid depletion of suitable ore bodies in the Masabi Range leads to an increasing need for the import by the United States of ore from Labrador and Venezuela. Such a development depends, however, on economical transport if these ores are to reach the large inland industrial markets at competitive prices.

These changes should lead to an increase of traffic on the river from the present 10 million tons a year, to over 30 million tons, of which 60 per cent. will take the form of grain and iron ore movements. Petroleum, coal and coke and forestry products will bring the total movement of bulk products up to about 85 per cent. of the immediate tonnage potential of the Seaway.

How far this internal American trade will be increased will depend to a large extent on the toll policies adopted by the Seaway authorities and upon the attitude that both Canada and the United States will take to this trade which is at present subject to the restrictions placed upon foreign carriers engaged in internal and coastal trade. These restrictions, which do not apply in Canada to Commonwealth ships, is at present undergoing review in Canada by a Royal Commission.

Owing to United States insistence the cost of the new developments must be amortised in 50 years by the receipts from tolls, and discussions on the rate of toll for different classes of shipping are under discussion. The first question to be decided is what amounts should properly be included in the costs of construction of the Seaway on which interest and amortisation charges will accrue. Then there must be agreement on the methods of actual collection and division of the tolls. Finally there is the thorny problem of the actual system of tolls to be used and the estimation of the probable traffic volume on which they can be levied. There is obviously a fertile field here for the pressure of interest groups and for political lobbying. One of the questions to be decided is whether the long-distance trade in large vessels should be encouraged by tolls which favour them at the expense of the existing lakers and small canallers or whether the larger vessels should pay charges proportionate to the costs incurred in enabling them to use the Seaway.

Speaking in October last year, the Honourable Lionel Chevrier, Q.C., the President of the St. Lawrence Seaway Authority, said that at that time there was no toll policy. He gave an assurance, however, that the toll policy would be free from any form of discrimination between different commodities, between Canadian and American traffic or between local and overseas traffic. Whether it will in practice be possible demonstrably to achieve this objective remains to be seen.

The growth of trade between North America and Europe and also with the east and west coasts of South America, the east coast of Africa, the Middle East and India, should lead to an increasing use of the facilities of the enlarged river system. From the point of view of exporters in North-Western Europe, it has the great advantage that the water lane from the large majority of Great Lake ports to North-Western Europe is shorter than the combined railway-ocean shipping routes involved in transport to the Great Lakes through United States coastal ports. It is clear that British manufacturers, as well as British shipowners, will be provided with exciting new opportunities when this great new highway is finally opened.

Weekly Survey

Cover Picture: *A stage in the construction and assembly of an engine bulkhead for a Britannia airliner. The principal material is light alloy, but titanium and stainless steel are also used.*

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Anatomy of Industry

New ground has been broken by the National Institute of Economic and Social Research in a booklet called "Company Income and Finance, 1949-53" on the compilation and analysis of company profit and loss accounts and balance sheets. In this booklet some 3,000 public companies in this country whose shares are quoted on British stock exchanges have been classified into industrial groups covering all major industries. Certain summary groupings have also been devised. The information for each industry has been analysed into three tables—appropriation of income for the year, balance sheet summary and sources and uses of capital funds.

There is a great deal of valuable information on the financial anatomy of these different industrial groups which will be of considerable interest to engineering concerns doing business with them. It will also be possible for engineering companies to compare their own experience with the average of the engineering industry. From all the statistical information available it would be perhaps most interesting to comment briefly on the third table, namely, the sources and uses of capital funds. From these tables it is apparent that internal sources accounted for more than 60 per cent. of total funds available; new credit from suppliers, banks, etc., accounted for 20 per cent.; and new capital issues for only 14 per cent. About 25 per cent. of these funds were spent on fixed assets each year, another 25 per cent. on stocks, 17 per cent. on extended credit to customers and 8 per cent. on increasing liquid assets. The authors of the booklet point out that the best measure of "net expansion" is the total net expenditure on fixed assets and working capital. Over the four-year period under review, 48 per cent. of net expenditure went on fixed assets and 52 per cent. on working capital of which by far the largest portion is accounted for in increased values of stocks due to rising prices. One of the interesting conclusions which comes out of the investigation is that if gross trading profits are taken as a measure of the growth of companies, the larger companies increased more rapidly than the smaller ones.

The Board of Trade has already announced that the work undertaken by the Institute is to be continued officially and that the results will be published for years after 1953 as a regular statistical feature in the Board of Trade Journal. This will be a most valuable body of statistics as it builds up over a period of years and becomes increasingly topical. Topicality is important since published accounts, which are the raw material on which these statistics are based, are inevitably 3 to 12 months out of date before they are published.

★ ★ ★

Prospect of Europe

A confessedly optimistic assessment of the growth in Europe's economy between now and 1960 is given in volume 2 of the 8th annual report of the Organisation for European Economic Co-operation issued last week. The basic assumptions of full employment, viable exchange rates and a solution to member-countries' balance of payments problems are taken for granted, as also is an absence of upheaval in the early stages of the European Common Market and the Free Trade Area. These are big assumptions but they are quite legitimate if one wishes, for example, to indicate the probable lines of capital investment given a basis of economic stability.

Productivity is expected to increase rapidly though not as quickly as in the 1950's, since full employment is now becoming general and fewer women are thought likely to go into paid employment. Granted that the consumer will take his full share in the increased output, that defence expenditure does not become an increasing burden and that organised workers will begin to take leisure instead of higher wages on an increasing scale, the report makes some general forecasts about capital outlay.

Spending on roads and schools is expected to double. It is interesting that the high rate of capital expenditure on education is put down in part to the need for better scientific education, as distinct from craft skills, and the need for a bigger supply of teachers, engineers and technologists. The emphasis on new and modernised roads is probably a safe prophesy since in many countries the road system is woefully out of date.. The rather more surprising forecast is made, however, that inland waterways will carry a bigger increase in freight than road transport. Air transport is expected to double but rail transport is expected to go up only by 10 per cent. There is expected to be some strain on Europe's shipbuilding capacity mainly due to increasing demands for tanker tonnage.

Large increases in investment are expected in nuclear energy, oil refining and oil exploration in Europe, and coal and electricity are expected to maintain their recent high levels. In transport, the largest single item of investment is expected to be in road vehicles and this is in spite of the big expansion there must be in harbour and dock facilities. The point is made on iron and steel that investment costs per unit of output are likely to rise considerably because more steel works will have to be started on new sites.

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Export Opportunities in Belgium

The holding of the Brussels Universal and International Exhibition next year, will concentrate attention on Belgium both as a market and a producer. Although only a small country barely 150 miles across at its widest, Belgium's nine million people have one of the highest standards of living in Europe. Last year Belgian exports increased by 13·4 per cent. and imports by 14·3 per cent. Exports and re-exports from the United Kingdom were valued at £73·3 million, an increase of 9 per cent. over 1955. Belgium is a highly competitive market in which price and quality are of supreme importance. Large orders for paper making machinery have been secured by British firms for the Papeteries de Belgique at Langerbrugge, the largest paper mill in Western Europe. This included a 255 in. high-speed newsprint paper making machine with a maximum speed of 2,000 ft. a minute.

Several important development schemes either proposed or in their early stages may present opportunities to British manufacturers. These include the modernisation and re-equipment of the port of Antwerp on which £30 million investment will be spread over 7 to 9 years. This work includes replacement of cranes and other installations as well as reconstruction of jetties and docks. There is also a proposal to extend the harbour at Zeebrugge to take large tankers. The work in connection with the 1958 Exhibition itself, with the various road improvements that go with it, has led to an increase in imports of earth-moving machinery and other equipment. Considerable sections of the Belgian railway system are due for electrification and the construction of research reactors is planned as part of the Belgian atomic energy programme. But while there is clearly plenty of scope for increased British penetration of the Belgian market, it will need hard work. On last year's performance, unless a further increase takes place, Britain's share of Belgian imports will not be maintained.

★ ★ ★

Reviving Machine Tool Orders

Average delivery periods for machine tools continue to shorten. According to figures published last week, the total order book at the end of January stood at £96·96 million compared with £97·96 million at the end of 1956 and a peak of £104·99 million in June, 1956. At the same time deliveries in January reached the record value of £8·72 million, so that at current rates of output, January's backlog represented just over 11 months' work.

Both home and export deliveries in January were the highest yet recorded, and while home deliveries for the sixth month in succession exceeded orders, export deliveries at £2·08 million were below the record export orders received of £2·53 million. The drop in outstanding orders since July last year is the result of a large drop in the home market accompanied by a slight rise in the export market. Home orders were still in January at the low level of £4·96 million, though they showed some improvement over the very low figure of £4·12 million for December.

Mr. Thorneycroft in the Budget debate last week drew attention to the obvious fact, frequently overlooked, that there can not be more investment than there are capital goods in which to invest. To attempt to overstretch the capital goods industries merely results in lengthening order books, higher prices, and large imports of steel. All these have been happening over the past two years or more in the machine tool industry. Over-long delivery dates became so much the rule that when the boom in home machine tool orders was halted towards the end of last year it caused some alarm. It is worth remembering that investment in the private sector of industry reached a record level last year, and Mr. Thorneycroft stated that he expects it to remain at about this level in 1957. The January upturn in home machine tool orders may indicate that last year's recession in orders was purely temporary.

It is also cheering that export orders continue to increase. Last year's excess of imports over exports must be regarded as very largely due to the investment boom of 1955, and the consequent overloading of the British industry. With production more nearly matched to demand, and the reduced level of orders in 1956, there should be a more healthy balance in 1957. The rise in production has however been partly due to an accession of skilled labour from the motor industry, and it is to be hoped that the revival of the latter will not again draw these men away from machine tool production.

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Tractors for China

At long last the United States Government have yielded to the considerable pressure put upon them by this country and Japan to relax the embargo on exports to China. The export control list will be brought into line with that applying to Soviet Russia and east European states. This will mean that farm tractors, road vehicles, various types of railway equipment, chemical plant, and other engineering products for which a market is known to exist will be freed. The impact of this decision on the trade of some industries may be considerable. The Agricultural Engineers Association played a prominent part in bringing about the change. Their members will now reap the benefits.

Recently the Association gave publicity to a broadcast from America by Christopher Serpell in which he said that behind the scenes in Bermuda, Mr. Macmillan and his colleagues were telling their American opposite numbers "you could not explain to a man in Coventry

why he was allowed to sell a tractor to the Russians and not to the Chinese."

At a recent conference, Mr. Lionel Harper, president of the Association, gave news of the progress made in recent months. The "vast potential for the export of our tractors and agricultural machinery" was brought to the notice of the Board of Trade a year ago, and since then 300 tractors and 700 implements have been exported, to the value of £700,000. British goods can compete with almost anything Eastern Europe has to offer but, as Mr. Harper pointed out, "a complete lifting of the curtain is essential, and that very soon, if we are to compete on an even footing." Exports from Western Germany and France have increased by considerably greater margins than our own, and obstacles are continually being placed in the way of British exporters. The China Section of the London Chamber of Commerce reviewed the position in their annual report for 1956, indicating that they will concentrate on organising group visits to China, and are preparing to issue an invitation for a Chinese technical mission to visit this country "at an appropriate time in the future."

The April issue of the China Trade and Economic Newsletter publishes useful statistics on market potential. Approximately one fifth of Russia's total foreign trade is done with China, worth some £450 million a year, and greater than our total trade in 1956 with India, Pakistan and Ceylon. Particular emphasis is placed on the demand for coal mining machinery. Applications for export licences, which include Diesel engines, electrical generators, and a wide range of other engineering products are being made. Arguments can doubtless be put forward concerning China's inability to pay for large imports but they apply equally to other undeveloped countries. The relaxation of the embargo is a welcome step forward. But much remains to be done if trade relations with China are to become normal.

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Agricultural Machinery Exports

The hopes of agricultural machinery manufacturers that 1957 would see an improvement in exports are so far being fulfilled. According to the latest figures provided by the Agricultural Engineers' Association, Limited, exports of both agricultural machinery and agricultural tractors in January and February, 1957, were appreciably above the figures for the corresponding periods in 1956. Tractor exports are up by 16 per cent. and agricultural machinery exports by 5 per cent. The figures for agricultural machinery are incomplete as those for combine harvesters are not yet available, so that the actual position may show a greater improvement than this.

In its latest Trend Review, the Association draws attention to the fundamental differences between the distribution of the agricultural machinery industry's overseas trade and that of other British engineering industries. The main destinations of United Kingdom engineering exports are the Commonwealth countries. In contrast, of the 15 largest markets for agricultural machinery for the years 1955 and 1956, only five are in the Commonwealth. Exports for these two years have been aboit evenly divided between Commonwealth and non-Commonwealth countries, but it is significant that whilst the total value of trade with the five Commonwealth countries fell by £137,000 from 1955 to 1956, exports to the ten non-Commonwealth countries rose by £647,670. The Association believes that this pattern of trade distribution deserves careful study as indicating that the prospects for trade in the non-Commonwealth countries, if intensively developed, might be appreciably greater than in the Commonwealth countries.

The Association also draws attention to the developing pattern of German export strategy in the Middle and Far East. German exporters have been making intensive efforts in Turkey and in Persia where German specialists will establish model farms, help in the organisation of research institutes and provide teachers in various technical schools. The West German Foreign Minister's visit to New Delhi and the Federal Vice-Chancellor's visit to Pakistan have both been aimed at strengthening German economic ties with those areas, while there were over 400 German exhibitors at the German trade fair in Cairo.

While the overall picture for the British agricultural machinery industry is fairly reassuring, this is principally due to increased production and sales of tractors. Both home and export sales of tractors in the first two months of 1957 show a marked improvement over the figures for 1956. Agricultural machinery, however, shows a heavy decline in home sales compared with 1956, which was itself a lean year, and a decline in total production. Any marked improvement in the agricultural machinery industry depends largely on steady expansion of export markets. It is reassuring that such an expansion, though at present slow, is taking place.

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Big Orders—Low Output

The shipbuilding boom shows no sign of abating and the congestion in the yards' order books steadily increases. Although the volume of orders received so far this year is below the exceptionally high level recorded in the last quarter of 1956, it is approximately double the rate of output. In the past 12 months the orders booked totalled 2¾ million tons (launchings were 1·3 million tons). The 90 ships aggregating 600,000 tons for which orders were booked in the first three months of the year bring total orders to 896 ships, 6·74 million tons and £915 million.

But Lloyd's shipbuilding returns also tell another, not so cheerful, story: launchings in British yards in the 12 months to March 30 were less than the previous year. They declined as a proportion of world launchings from 28 per cent, in the previous 12 months to 18 per cent. On the other hand, Japanese shipyards recorded yet another increase in the tonnage launched. In the 2nd quarter of 1956 this amounted to 323,000 tons (Britain's figure was 306,000); in the first quarter of 1957 the corresponding total was 587,000 tons and Japan's share of world launchings from April, 1956, to March, 1957, accounted for 28 per cent. of the world's total. Yet the tonnage under construction in Japan was some 30 per cent. less than in Britain, and orders were also much less. British shipbuilding therefore has a fine opportunity to make up some of the lee-way it has lost in the past few years. Steel stocks built up last year and increased during the recent strike should allow a quicker tempo in the yards.

The inquiry into the causes of the strike revealed many differences between management and labour, but also an encouraging community of aim—to restore British shipbuilding to world leadership. A new constructive attitude may well emerge from the present period of stress. New methods are being introduced, and there are at long last signs that the rate of building will go up. This, above all else, is the tonic shipowners require—particularly foreign owners since British yards enjoy a reputation for quality which is unique.

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Shipbuilding Upside Down

New ideas are sprouting thick and fast in Britain's shipyards. This suggests that a new sense of urgency is being felt to increase output and reduce building time. Most shipbuilders have studied prefabrication and some are making use of the newest techniques. One of the most original ideas has come from Tyneside. Clelands (Successors), Limited, have increased the number of ships being built at one time and reduced the production cycle simply by constructing keels with double bottoms in the "upside down" position.

This is a quick method of prefabrication, used in a new 300 ft. shed. The inner bottom plates and lower ribs are welded first, and the outer plates riveted afterwards. The double bottoms are built in sections, each weighing up to 10 tons. They are then removed from the shed by mobile cranes and transported to the berth or to the storage yard. One of the main advantages of the new method is the high quality of welding it makes possible, by doing it uniformly in the down-hand position. Another is the fact that the building of a ship need not wait to be started until a berth is vacant.

The move towards the adoption of modern shipbuilding techniques is most encouraging. Some remarks of the late Mr. J. W. Elliott, chairman of Swan, Hunter and Wigham Richardson until his sudden death on March 20, are particularly so. In the company's report Mr. Elliott talked of "an order book which will keep our works busy some years ahead," but devoted more than half his speech to the various expansion and modernisation schemes now under way. One sentence in particular is revealing, and cheering, for it epitomises well the changing feeling in British yards: "Expenditure now envisaged is considerably in excess of that which was contemplated a year ago, due in part to increases in costs that have taken place, but largely due to the fact that we now have to revise our ideas of what is necessary to bring our works up to the necessities of these times." Whether this will mean building ships upside down or the right way up is not clear from Mr. Elliott's remarks. What is clear is that new capacity, new equipment and—even more important—new methods are on the way to British yards.

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Plans for Steel

Details of the major schemes passed by the Development Committee of the British Iron and Steel Federation are given in the Federation's annual report for 1956. This foreshadows the Iron and Steel Board's own report on the industry's development plans which will be submitted shortly to Lord Mills, Minister of Power, and will be published as a White Paper. Some of the schemes mentioned by the Federation still have to be approved by the Board but few changes are likely.

The new expansion programme, the third since the war, aims to raise output "to at least 28 million tons of steel in 1962," and will involve the expenditure of £575 million over the next five years. The objective originally set for the second development programme, of 20¼ million tons in 1958, was in fact exceeded in 1956 and it may well be that the new estimates of output will also prove conservative. The fact that they are based on the assumption that demand for steel will grow as much in the next six years as it has in the last eight indicates that the steel industry does not take a pessimistic view of the country's industrial future.

Several of the schemes have already been described by the companies concerned. In all, they involve the construction of 14 new blast furnaces, providing an increase in pig-iron capacity of 7 million tons over 1956 to 20 million tons, and eight new melting shops. One of the largest schemes is a new integrated steelworks to be built at Newport by Richard Thomas and Baldwins. The Steel Company of Wales and John Summers both plan extensions or major modifications to their sheet producing capacity. The proposed extensions to the rolling capacity for plate and heavy sections were discussed in an article "Steel Plate: The Threat of Scarcity", in the issue of April 12, page 457. It is in this, and in the production of some alloy steels, that the industry lags furthest behind current and likely future demand for its products. The plans described by the Federation do little to dispel anxiety in this respect.

The New B.I.F.

This year sees a change in the British Industries Fair. Government financial support having been withdrawn, and the two London sections discontinued, the Fair will be held at Castle Bromwich, Birmingham, only, from May 6 to 17. A visitor to Castle Bromwich is likely to find the general pattern there much the same as before, with engineering and the hardware trades predominating, but future Fairs may well be very different.

The B.I.F. has suffered from several disadvantages in the past, not the least of which is the fact that while its name implies that it covers the whole of British industry, in fact it does nothing of the kind. It has to compete with several specialist trade fairs, and as a consequence certain large and important sections of British industry are wholly unrepresented at the B.I.F. To quote only one example, no machine tools are shown at the B.I.F., though it could not be denied that machine tool making is an important branch of British industry.

On the other hand the B.I.F. does cover a very wide range of industrial products and it is and always has been, used for the first showing of much that is new. As an exhibition centre Castle Bromwich has much to offer. It is central and accessible, and has a large exhibition building which, if admittedly rather more utilitarian than handsome, is adequate for most purposes. With 3½ acres of outside stand space the existing 616,000 sq. ft. of covered area could easily be extended if necessary.

Many suggestions have been made for future Fairs at Castle Bromwich; among them is the proposal that the idea of a purely national exhibition should be abandoned, and that Castle Bromwich should become the centre for international trade fairs on the lines of some of the successful Continental ones. Such a radical change might prove a success, but the shortage of hotel facilities within reasonable distance of the site could easily negative any plans for attracting increased numbers of visitors. What happens in the future must, of course, be based on an appraisal of the Fair which opens in a few days. Castle Bromwich is, in some ways, on trial, and the verdict of the exhibitors and of the visitors, British and foreign, will be awaited with interest.

Letters to the Editor

FUNDS FOR BRITISH STEEL

SIR, The issue of your journal dated January 11 has just reached me and I feel impelled to comment on the Plain Words article on page 34, in which you plead with the rest of industry in the United Kingdom to accept increases in the price of basic iron and steel, in order to help the poor steel makers to expand their production facilities and by so doing accept part of the risk of over-expansion.

What risks are carried by the steel-making industry which are not also carried by the users and re-processors of steel and other basic metals? The steel users have to find, develop and maintain markets at home and abroad for their productions and carry all the risks associated with their enterprise. Their business is hampered by rising costs of basic materials and delays in delivery, but it is not suggested that they should be similarly assisted in their efforts by other industrialists; therefore, it is quite inequitable that the risks of steel making should be carried by any other than that industry, which does not create a demand for its products but only supplies a demand created by the activities of others.

From the statements of leaders in the steel industry, it will be observed that it has already been decided that steel prices *are* to be increased, with the object of providing funds for expansion, because, they contend, the money market cannot find the funds necessary for such capital development.

Where does the money come from anyway? Whether it is asked for as capital or taken as a surcharge on the price of the material, it comes, surely, from the national pool. Consequently, the money must exist and it is false to contend that the money market cannot provide the funds required. Three examples will provide an indication of the position. The capital issue of £30 million by the British Petroleum Company, Limited, resulted in applications totalling ten times that sum; the recent issue by Imperial Chemical Industries, Limited, of £40 million worth of stock brought applications totalling £240 million; and the Bowater group's recent offer of £15 million of stock resulted in applications for £220 million.

In each of these cases, the issues were restricted to existing shareholders and, as it is unlikely that each company has the same shareholders, there is obviously a large volume of money available for investment in sound undertakings, among which British steel undertakings could be listed.

It would be perfectly safe to assert that such firms would have no difficulty in raising all the capital needed for their developments, and thus avoid the impending advances in steel prices, which will increase the cost of all manufactured commodities having a steel component and, thereby, injure the national effort to extend the export market.

The future of the steel industry will not be assured by increasing steel prices, but rather by reducing them. This is a fundamental truth and needs no elaboration.

Yours truly,

G. A. JONES.

379 Waverley-road,
East Malvern,
Melbourne, S.E.5,
Australia.
April 24, 1957.

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AN ENGINEER'S CARD INDEX

SIR, I read with interest the excellent letter by Mr. R. Silvester on this subject in ENGINEERING of January 11, page 38.

The days when one could store in one's memory even a fraction of the technical matter one reads in the various books and periodicals now being published have gone. Indeed, it is an accepted fact that one's memory should not be taxed or strained unnecessarily, by having to memorise new formulae and techniques. To-day, even students in the examination hall are allowed reference books, and Master Crammer and his kind have no chance against the intellectuals.

Most factories and offices subscribe to technical and trade periodicals and maintain a reference library. After the new books and magazines have been circulated among the staff, they are, in general, stored in the library. But how many members of the staff will have stored in their minds the important information which the firm may be requiring in the future? One fine day, when this particular reference is required, the library shelves are upset and time is wasted, ironically enough, in a fruitless and frustrating search. Notes kept in a haphazard manner are equally useless.

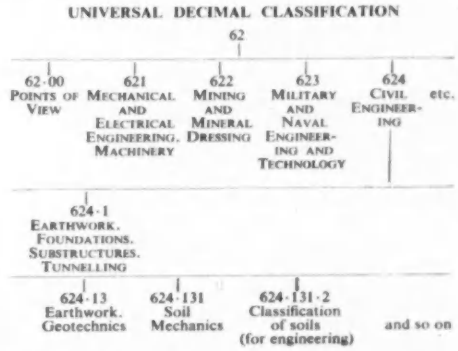
The card index system, on the other hand, has the advantage of a loose-leaf book in that its pages are always "alive." There is another great advantage. I always carry a few new 3 in. by 5 in. cards in my wallet, as one sometimes finds odd moments in which to visit a library or bookseller. Anything interesting can then easily be noted down on these cards, which can, in turn, be readily indexed and filed when one is back in the office.

After experimenting in the early stages, one discovers, or invents, the indexing and filing system most suitable to one's own work and aptitude. I, personally, have found the Universal Decimal Classification system to be the most scientific and versatile. It is an extension of the Dewey Decimal Classification and was prepared for use in the classification of original articles in periodical literature, and of other documents of all kinds.

In 1957, the British Standards Institution published the second, revised, edition of the Abridged English Edition of the U.D.C. It is a very handy bound booklet costing 42*s*., excellently prepared by a large number of specialists. It is also obtainable unbound at a price of 35*s*. This work classifies, in a very interesting and simple way, every subject of human knowledge, and groups these subjects from every point of view. By a systematic (what can be more systematic than the decimal system?) combination of numbers, a reader or investigator can build up a card index with the aid of the U.D.C. which is both broad in its coverage and specific in its concepts.

The point is made in the introduction to the first edition of the B.S.I. Abridged English Edition that the whole of human knowledge can be divided into ten groups, each of these groups being divided afresh by the addition of more decimal places, and that this arrangement permits the intercalation of new subdivisions at any point, and facilitates the learning by heart of the symbols. The decimal symbols thus offer mnemonic advantages over symbols made up of combinations of letters and Arabic or Roman numerals. As an example of this system, the number 62 denotes "Engineering and Technology Generally." The subdivision of this subject is illustrated in the attached table, from which the versatility of the U.D.C. is clearly demonstrated. It can be made as broad or as narrow as it is required to be.

UNIVERSAL DECIMAL CLASSIFICATION



Lastly, there is one other great advantage. As stated above, with increasing familiarity with the system and as one's card index slowly builds up, the individual user automatically remembers the relevant numbers and does not need to make frequent reference to the B.S.I. booklet. He associates his reading and searching with such numbers. Indeed, it is not uncommon to find a visitor to a library making direct for the particular shelf where he knows that he is sure to find literature dealing with his subject, since most libraries follow either the Dewey or the U.D.C. system of classification for their books and other literature.

I am in favour of the U.D.C. system for card indexing in preference to any other. Strangely enough, I was introduced to this system by a fellow Australian of Mr. Silvester; namely, Mr. R. Culver, reader in civil engineering at the University of Adelaide.

Yours faithfully,

R. SINGH,
Planning Officer.

India General Navigation and Railway Company, Limited,
44, Garden Reach-road,
Calcutta, India.
April 5, 1957.

Editor's note: Previous letters on this topic have appeared in our issues of January 11, page 38; January 25, page 101; February 8, page 165; March 15, page 326; March 29, page 388; April 12, page 453 (The Blanket of Literature); and April 19, page 485.

REPLACEMENTS FOR TRANSISTOR SUGGESTED

Magnetic Spin Effects and Photochromism Used for Switching

It might seem strange that the Harvard University should see fit to hold a four-day international symposium on switching. A switch is either on or off and there seems little more to the subject than that. Four international days devoted to a device of such simplicity appears refreshingly unworldly in this age of technological complexity.

The computer engineer would not subscribe to this view. He would be disturbed by its naïvety. For the switch is the *sine qua non* of digital computation. The switch is an invaluable component in logical networks (ENGINEERING, vol. 183, page 342, March 15, 1957) and thus any device which has the property of existing in two electrical states that can be identified as on and off has been receiving close attention. The chief properties required of a switch for computation are reliability, speed, compactness and low power consumption. Switches used so far in computers have been relays, vacuum tubes, rectifiers and transistors. At present the vacuum tube is the device used most extensively, but it appears to be on the way out.

Speaking of computers to be built in the immediate future, Dr. T. H. Bonn, of the Remington Rand Division of Sperry Rand, said " After 13 years of prominence, the vacuum tube is burned out as a computer component. One might well ask how long the transistor and magnetic amplifier will remain on the scene. Because of recent improvements in the reliability of transistors it is safe to say that most of the computers under development in the laboratory now will make use of solid-state pulse amplifiers and switches (such as transistors) rather than thermionic devices (that is, vacuum tubes)."

A paper prepared by Dr. M. A. Gavrilov, of the Academy of Sciences in Moscow, presented a general survey of the work being done on switching in the Soviet Union. Among other things he described a machine for analysing relay networks that is more comprehensive than other machines of its kind. An interesting sidelight revealed by his paper was that there are more papers published in Roumania on the subject of switching theory than in any other country, with the exception of the United States and the U.S.S.R.

Another speaker, Dr. H. Callen, Professor of Physics at the University of Pennsylvania, suggested that a replacement for the transitor will be needed for future high-speed calculators. " Within the few short years of computer development, fantastic increases of computer speed have been achieved. The eventual limit beyond which nature will forbid further advance is already in sight. This limit is set by the relativistic law that no physical signal can propagate with a velocity in excess of the velocity of light. The speed of calculation is therefore limited by the times required to transfer information from point to point within the machine. A characteristic distance is perhaps ten centimetres corresponding to a time of one third of a millimicrosecond. Computing times in the millimicrosecond range are only two or three orders of magnitude faster than presently planned machines, and are already the topic of at least tentative exploration. As each increase in computing speed has occurred, it has been accompanied by the development of a new basic component. The mechanical relay yielded to the vacuum tube, and that in turn has been supplanted by the solid state devices such as magnetic cores and transistors. Thin ferromagnetic film is a new component of the latter class and is one of the few components which may be expected to perform successfully at one millimicrosecond switching speeds."

The basic phenomenon used in the thin magnetic films is the reversal of magnetic spins. Two methods of reversing the spins appear possible. Either the spins can be made to rotate in " parallel "—referred to as rotational; or the spins can rotate in " series "—the local region in which spin reversal occurs advancing across the specimen in the form of a domain wall. The rotational method is faster and can readily be achieved on film.

An incredibly tiny switch—one hundred million of them would cover a square inch—was described by Mr. B. K. Green, of the National Cash Register Company. The switch is the first to use chemical principles as the basis for its mode of operation. If certain materials are exposed to lights of different colours, the material itself will change colour. The process is reversible and is known as photochromism. The different stable states corresponding to different colours provide the basis for a switching action. In practice three different colours of light may be used to read, write, and erase the information in each material, making it possible to extract the information without destroying it. The photochromic materials are used in solution and take the form of tiny droplets enclosed by capsules or cellular structures. An automatic process has been developed to produce many billions of the cells in single batch operation. Each cell is about 2½ microns in diameter and they may be assembled in single layers. The speed of switching is about 1 millisecond.

TRAINING FRENCH CANADIAN ENGINEERS

The École Polytechnique in Montreal

Although it has been said that the last shot fired in defence of the British flag in North America will be fired by a French-speaking Canadian, the social and political barriers that separate the two main groups which make up the Canadian population remain an astonishing phenomenon. The basis of this division is, of course, far deeper than language and is rooted in religion, education and cultural outlook. Until recently the Province of Quebec, with a population of whom three-quarters speak French, often as their only language, was largely a farming and forestry province, with its people, outside the cities of Montreal and Quebec, living in small communities in which the Church was the most prominent building.

The development of hydro-electric power for the production of aluminium and for industrial use, and the discovery and exploitation of iron ore and non-ferrous metal deposits have, since the war, brought about considerable changes in Quebec's economy and there are now signs of the Province narrowing the gap between its level of economic development and that of the new industrial provinces. For example: ten years ago the Province of Quebec, with 28 per cent. of the population of the country, had only 5½ per cent. of its qualified engineers; to-day, that figure has been raised to 12 per cent. and it is still growing.

One of the main contributors to this increase is the École Polytechnique, which is the technological faculty of the Catholic University of Montreal. Together with the engineering school of McGill University, also in process of development, the École Polytechnique produces most of the professional engineers in the province. Founded in 1873, it was developed along the lines of the corresponding institutions in France, but in 1878 became part of the Montreal branch of Laval University which itself became an independent university in 1889. A charter of incorporation was finally voted by the legislature of the province in 1895.

The present buildings in downtown Montreal have been expanded from those commenced in 1902, the last addition being made in 1945; but there is now nearing completion a new modern building on the campus of the University on the north slope of the Mount Royal. This magnificent structure, built with a grant from the Provincial Government, will provide a floor space of over 500,000 sq. ft. or double that available in the existing premises. It will house all the faculties which include civil, mechanical, electrical, mining, metallurgical and chemical engineering as well as applied geology and the pure science departments of mathematics, chemistry and physics. Ten years ago the number of students was 350; to-day it is 900 and the new buildings will accommodate 2,000, the number anticipated within the next 15 years.

Courses of instruction are conducted in French but, to quote the current calendar, " as graduates of the Polytechnique will for the most part be called upon to exercise their profession in accordance with American practice and, very often, will have to work in collaboration with engineers speaking English," it is considered necessary to use mainly English text-books, chiefly those published in the United States. The normal course is a five-year one of which the first two are mainly devoted to mathematics and basic science. A graduate receives both his diploma giving him the title Engineer in accordance with French practice and a degree of Bachelor of Applied Science from the university.

These entitle him in France to the same title of Engineer as a graduate of one of the French engineering schools and so to work in any of these schools for a doctorate and also to registration as a member of the Association of Professional Engineers in Quebec, without which he may not, by law, practise the profession of engineering.

In addition to its teaching facilities, the École Polytechnique has established a research centre with the object of promoting studies in pure and applied science; helping firms solve their scientific and technical problems; stimulating research among the staffs; trying out new industrial inventions and so on. Interesting work is being carried out in hydraulic engineering and in metallurgy, particularly on the study of pressure vessels at high temperature.

The École Polytechnique of Montreal houses all the engineering faculties and will accommodate 2,000 students, the number anticipated within the next 15 years.

CONTROL OF QUALITY IN CASTINGS

One whole day during the spring meeting of the Institute of Metals, held in London from April 29 to May 3, was devoted to the consideration of eight papers dealing with the "Metallurgical Aspects of the Control of Quality in Non-Ferrous Metal Castings." This conference, or symposium as it was called by the Institute, had been arranged by its Metallurgical Engineering Committee, in conjunction with the Institute of British Foundrymen. It took place on Wednesday, May 1.

Three of the eight papers presented were general in character and dealt respectively with the metallurgical principles involved, the role of statistical methods, and the use of non-destructive testing in controlling the quality of non-ferrous metal castings. The remaining five papers were concerned specifically with aluminium, copper, magnesium, and nickel alloy castings and with pressure die-castings.

METALLURGICAL PRINCIPLES

"The Metallurgical Principles of the Control of Quality of Non-Ferrous Castings" were dealt with in a communication from the British Non-Ferrous Metals Research Association, and in the course of their paper the authors, Mr. R. W. Ruddle and Mr. A. Cibula, stated that an analysis of the defects in rejected castings suggested that greater attention to gating practice was often a most rewarding measure in the control and improvement of casting quality. The principal requirement of the running system was that it should not allow turbulence in the stream of metal to exceed the point at which "agitation" occurred. Another important feature of a good running system was that it should limit the velocity of the metal sufficiently to prevent erosion where the stream impinged on the mould surface. This precaution was of greatest importance with the denser metals, such as the copper and nickel alloys. The position of the gates should allow an adequately smooth flow of metal to be maintained whether the mould cavity were empty or full, and temperature gradients to be set up which minimised shrinkage porosity and distortion. Finally, the runners should be as short as possible to avoid the necessity for high pouring temperatures and to reduce the proportion of scrap metal from the runners.

Castings in certain alloys of long freezing range exhibited a particularly damaging form of microporosity, known as "layer" porosity when fine-grained, the small shrinkage cavities being arranged in numerous layers. The principal alloys in which this occurred were magnesium alloys, aluminium-10 per cent. magnesium alloy and tin-bronzes and gunmetals. The problem could be dealt with by directional-solidification methods and by ensuring that the temperature gradients towards the feeder were steep. For example, heavy chills might be attached to the end of the casting opposite to the feeder, or exothermic compounds or insulating sleeves applied to the feeder.

STATISTICAL METHODS AND NON-DESTRUCTIVE TESTS

The second general paper, by Mr. A. R. Martin, of the Northern Aluminium Company, Limited, Birmingham, demonstrated the role that statistical methods could usefully play in facilitating the correct interpretation of the information provided by inspection records. The author stated that the appropriate statistical approach was determined in the first instance by whether the process was being controlled by measurements of properties such as tensile strength, composition, or permeability, or whether it was being controlled by the assessment of attributes such as the presence or absence of casting defects. Moreover, the data to be entered on control charts must be considered in relation to the accuracy of the measurements being made.

In his contribution on "Non-Destructive Testing in the Control of Quality," Mr. S. L. Fry, chief radiologist of J. Stone and Company (Charlton), Limited, London, said that the methods suitable for use with castings comprised visual inspection, various liquid-penetration methods, pressure testing, ultrasonic testing and radiographic examination. Of these, radiographic inspection was the method capable of giving the greatest range of information.

When producing radiographs, each section of the casting should be viewed clearly and as far as possible unobscured by other parts of the casting. Each section should be as close to the film as possible, and the beam should pass normally through the section to be examined. This was to avoid distortion and so make possible a more accurate diagnosis. The exposure should be correct for the area under examination to achieve the desired density in the final radiograph. Finally, it was extremely useful if each section could be radiographed in two directions. With castings other than the simplest, it was not possible to fulfil all these conditions and a compromise must be made. It was in balancing the various requirements that skill was needed.

ALUMINIUM, COPPER, MAGNESIUM AND NICKEL ALLOY CASTINGS

A paper by Mr. A. V. Carless, of the Birmingham Aluminium Casting (1903) Company, Limited, Smethwick, reviewed some of the more important aluminium casting alloys in common use and discussed methods adopted and precautions observed in the control of quality in castings made in these and kindred materials. He stated that in a foundry where many different alloys might be in regular use at the same time, a dependable system of alloy segregation was essential for adequate control. At the knock-out station, for example, runners and risers were identified at the earliest possible moment by marking them with a fast-drying paint—a rigid colour identification scheme was used—before stripping down had proceeded very far. When sampling, the test specimens should be taken as near to the time of casting as possible and after all metal treatment was completed, so that there could be no question concerning the authenticity of their representation.

Heat-treated castings probably represented the major portion of the output of a modern aluminium casting foundry and temperature, time and other variables required close control to ensure the uniform quality of the finished article. Records should be detailed and fully comprehensive and, under most official inspections, must be held available for five years.

When dealing with copper-base alloy castings, Mr. A. R. French, senior metallurgist to J. Stone and Company (London), Limited, said that in the control of quality of copper-tin alloys, an important development introduced into practice after 1945, had been the use of scavenging methods for degassing after melting. The plunging of marble chips had been effective and, currently, the use of calcium cyanamide in a similar way was being attempted. Nitrogen degassing was widely used but the cost of the nitrogen and of the rather fragile graphite or plumbago tubes had to be taken into account.

The measurement of temperatures presented a problem when working with copper-base alloys. The determination of temperature was an essential in the control of quality, but completely reliable and serviceable equipment was not yet available. Techniques were being considered at present which eliminated the immersion of protected thermocouples in the metal and depended instead upon the measurement of radiation from the bottom of a closed tube. A relatively recent development, important in the economic production of castings in copper-base alloys, had been the introduction of exothermic and porous plaster sleeves for feeders.

In their paper on magnesium-base alloy castings, Dr. E. F. Emley and Mr. P. A. Fisher, of Magnesium Elektron Limited, Manchester, said that magnesium alloys raised problems of special interest in the casting field on account of their high chemical reactivity, low density, low volume heat capacity, general fine grain-size, and their tendency to exhibit microporosity on occasions. The alloys fell roughly into two groups, characterised by the presence of either zirconium or aluminium, and alloys containing zirconium now constituted the major proportion of magnesium castings for aircraft usage in Great Britain.

Sand castings at present in production varied, in fettled weight, from a fraction of an ounce to about 15 cwt. and included some of the most complex shapes ever attempted. Gravity die-castings were normally of much lower maximum weight, although a few very massive castings of simple shape had been made in metal dies where this had proved more convenient than the use of sand moulds.

Pouring was normally the only stage of the whole process of casting at which there was any risk of flux inclusions arising and it was also one at which oxide inclusions could be produced. As a consequence, pouring was worthy of craftsmanship. It was probable that radiography had been applied more universally to magnesium-base castings than to those of any other metal. Radiography was indispensable in developing running methods for castings of the highest quality, although, as with all inspection techniques, it must be used intelligently and with an appreciation of its limitations.

In their paper on the "Control of Quality in the Production of Nickel-Alloy Sand Castings," Mr. D. R. Wood and Mr. J. F. Gregg, of the Mond Nickel Company, Limited, Birmingham, said that the basic principles underlying the melting and casting of nickel-base alloys, in general, were similar to those of steel. Time and temperature were two major factors affecting reactions occurring during melting, and the control of quality during melting was dependent on the strict control of these variables. Small contents of sulphur and lead were deleterious but their effects were less pronounced in nickel-chromium than in nickel-copper alloys. By oxygen lancing nickel-copper and nickel-chromium-iron alloys, a high level of mechanical properties was obtained from scrap-metal charges and the weldability of the nickel-copper alloys was also improved. The high melting point and the high liquid and solid contraction of nickel-base alloys, combined with their relatively low strength at temperatures immediately below the solidus, called for the use of highly refractory moulding sands, substantial feeder systems and mould designs permitting the unhindered contraction of the metal, in both the liquid and the solid state.

PRESSURE DIE CASTINGS

Mr. H. J. Sharp, of Hoover Limited, Perivale, Greenford, Middlesex, in the course of his paper on "The Control of Quality of Pressure Die-Castings," said that far too much time was devoted to checking raw materials to ensure that they complied in composition with specifications, without a proper assessment having been made of just how important the composition limits specified were. This was particularly the case with aluminium alloys. Similarly, far too much emphasis was placed on mechanical properties. The general run of pressure die-castings, at least, merely formed a base to which were attached many other components, and provided that there was sufficient metal at the right places to form the various flanges and bosses required for drilling and tapping, the casting as a whole would almost certainly have more than adequate strength for its purpose, even if its composition happened to fall well outside the specified limits.

In pressure die-castings, it was important to control the composition of the metal being cast only in so far as this affected castability, machinability, sometimes corrosion resistance, and, occasionally, physical properties. The most important physical property from the point of view of performance was adequate impact resistance. In addition, for some applications, ductility was required.

HIGH-SPEED SHELL-MOULDING RESIN

A synthetic resin which, it is claimed, brings new economies to the shell-moulding process and thus enables castings to be produced at lower cost, has recently been developed by British Resin Products, Limited, Devonshire House, Piccadilly, London, W.1.

The resin, Cellobond JX5040, is a liquid containing methanol and is utilised for the cold coating of all sands suitable for shell moulding. To each 100 lb. of sand from 3 to 6 lb. of the resin is added, according to requirements, and then 6 per cent. of hexamine on the weight of the resin present. The purpose of the hexamine is to cure the resin. The mixing is said to be simple; the resin is poured on to the sand and after it has been dispersed the hexamine is added. Mixing is continued and when the product attains a granular condition, it is ready for use.

Pattern temperatures of up to 250 deg. C. are suitable, but it is recommended that the temperature should be between 180 deg. and 220 deg. C. Within this range the thickness of the shell formed on the pattern after 5 seconds is 0·21 in., after 10 seconds 0·27 in., after 15 seconds 0·31 in., and after 20 seconds 0·35 in. A slightly higher rate of "build-up" may be expected at temperatures above 220 deg. C. It is pointed out that only slight lubrication of the pattern plate is required as there is little tendency for the resin to migrate to the plate surface, and mould sticking is thus unlikely. On the other hand, excess lubricant can be detrimental to the production of satisfactory shells and dimensional inaccuracy can result from the accumulation of surplus releasing agent. On account of the rapid rate of shell production which takes place with sand coated with the new liquid resin, it is claimed that investment times are approximately half those required by powdered-resin/sand mixes.

Cores can be prepared with the aid of the new resin by either the dumping or the blowing methods. No special precautions are necessary but the box must be emptied quickly on account of the rapid rate of the build-up.

* * *

COPPER DEVELOPMENT ASSOCIATION

Founded in 1933, the main function of the Copper Development Association is to provide technical information and advice on applications of copper and copper alloys, and to furnish a link between research and industry. It is a non-trading organisation and its aim is the extension and improvement of existing applications of copper and the development of new uses for the metal and its alloys. The services of the Association, which is financed mainly by the copper-producing countries of the British Commonwealth and the British fabricating firms, are available to all applicants without charge or obligation.

For some time after its foundation the headquarters of the Association were in London, but for a number of years they have been at Kendals Hall, Radlett, Hertfordshire. Recently, it was decided to return to London and, last month, Viscount Chandos, P.C., formally opened the Association's new offices and display room which are situated at 55 South Audley-street, Mayfair, London, W.1.

The display room has eight exhibition recesses, one dealing with the metallurgy of copper, and each of the other seven depicting an application of copper or copper alloys in the electrical, engineering, and chemical industries, and in roofing, agriculture, pipe work and the home.

In addition to office accommodation, the new headquarters include a board room, a library and a small metallurgical laboratory.

WIND GUST PATTERNS

TURBULENCE INVESTIGATIONS IN ORKNEY

By M. P. Wax, B.SC.(ENG.), A.M.I.E.E.*

This article is a digest of technical report No. C/T114, "An Experimental Study of Wind Structure (with Reference to the Design and Operation of Wind-Driven Generators)" published last year by the British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey.

Turbulence of the air is of vital concern to anyone who hopes to utilise the vast reserves of power available in the wind, to use the air itself as a medium of transport, or merely for the dispersal of factory fumes, or who has to allow for its effects in structural design, or when a particularly strong gust threatens to whip up a hat or a skirt.

It may be considered as variations in velocity of the wind superimposed on the mean velocity, but these variations cover a wide range of amplitudes, directions and rates of change. It is created by the setting up of eddies which may be due to variations of temperature or pressure in the air itself, to friction with the ground, or to obstructions; these eddies, once produced, are carried on, continuously changing in form by interacting with one another and with solid objects and by the damping effect of the air, which again varies with atmospheric conditions. It is not therefore surprising that any theoretical analysis is extremely complicated, and statistical methods must be used. Fortunately, in many of the fields where turbulence is of concern, limited information of extreme values serves most needs, although there must always be a search for further knowledge of the factors involved, to give a better idea of the conditions in which these values can arise. The investigation described in this article was carried out to determine the likely effects of gustiness on the extraction of power from the wind; the report gives preliminary results taken on a 120 ft. mast on Costa Hill in Orkney, where it was proposed to erect a wind-driven electric generator to operate in parallel with the existing Diesel generating station in the county town of Kirkwall.

* Formerly attached to the British Electrical and Allied Industries Research Association Windmill Research Station.

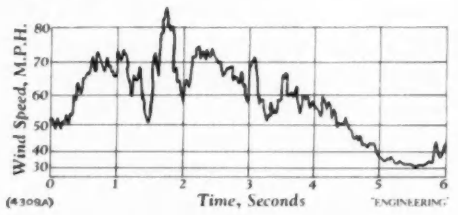


Fig. 1 A section of one of the most gusty records, taken on a 30 ft. mast. Changes of over 5 m.p.h. at rates of 200 m.p.h. per second occur frequently.

Two new types of anemometer were developed for the project. One, designed by Mr. H. H. Rosenbrock, converts variations of deflection of a small perforated sphere exposed to the wind into electrical signals and gives a continuous record of the instantaneous wind speed on a pen recorder. The other is a small windmill-driven alternator. Its rotational speed is proportional to wind speed, and so therefore is the frequency of the output, the cycles being counted in an electronic digital counter. This count is a measure of the run of wind, or wind speed integrated over the period selected, which can be from one second upward. In both these instruments, the inertia of the moving parts has been reduced to a minimum to ensure rapid response to gusts.

Fig. 1 shows a small section of one of the most gusty records taken on Costa Hill, on a 30 ft. mast. The gustiness may be due to the instability of the air, but the wind was blowing on a bearing of 340 deg., and 400 yards distant in this direction was a 400 ft. cliff dropping sheer into the sea. Changes of over 5 m.p.h. at rates around 200 m.p.h. per second occur frequently in this record while the maximum, shown in the section reproduced, is of over 22 m.p.h. in 0·1 second, part of a total rise of 34 m.p.h. in 0·25 second. These rates of change, of around 200 m.p.h. per second are not unusual here in a gusty wind blowing on any bearing; the time for which they last is the exceptional feature in extreme gusts.

Part of a more normal record is shown in Fig. 2, where rates of change of 100 m.p.h. per second are the fastest observed. This shows simultaneous records from four gust anemometers mounted at the ends of the vertical and horizontal diameters of a vertical circle of 60 ft. diameter and 88 ft. centre height, corresponding to the swept circle of the proposed generator. As would be expected, the top

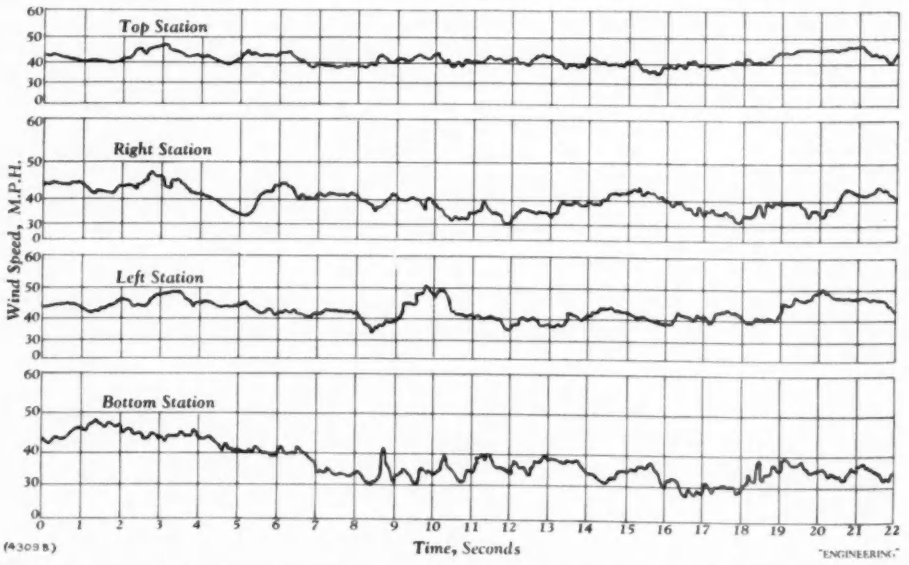


Fig. 2 A more normal record, taken from four gust anemometers mounted at the ends of the vertical and horizontal diameters of a vertical circle 60 ft. in diameter with a centre height of 88 ft.

record is the least gusty, the eddies due to the ground irregularities showing up more at the lower levels. There is little apparent correlation between the four records although adjacent anemometers are only 42 ft. apart, indicating that most eddies must be smaller than this. These records were taken on a mast erected on the hilltop where the generator was to be sited, the wind speed and hence the power available being appreciably higher there. No work was done at other points to determine the effect of the rising ground in compressing the lower layers of the air, damping down the gustiness, although it is likely that this occurs.

Steady winds are also of interest in wind-power generation, and the record from which Fig. 2 was extracted five seconds later steadied to give barely perceptible changes in wind speed, at a mean between 40 and 50 m.p.h., for over 40 seconds, then gradually reverting to the form of Fig. 2. Taking an arbitrary definition of steady as within $\pm$ 1 m.p.h. of a mean value for at least 2 seconds, the proportions of the total record of 25$\frac{1}{2}$ minutes which were steady were 33 per cent. at the top, 24 and 25 per cent. at the sides and only 9 per cent. at the bottom, again showing the greater gustiness experienced at the lower levels.

In considering the effects of gustiness on a moving object such as an aircraft wing or windmill blade, it must be remembered that an object moving through a steady wind gradient will experience a change of wind speed similar to a gust. Thus, assuming a vertical wind gradient proportional to the ratio of the heights to the power 0·4 and a perfectly smooth wind with a speed of 50 m.p.h. at a height of 90 ft., an object moving vertically at 250 ft. per second will experience a change of wind speed of 75 m.p.h. per second, while even greater changes will occur with a windmill blade moving through the tower shadow. Any gustiness is superimposed on these fluctuations.

While the effect of the change of speed on a blade or wing moving with any appreciable velocity will be small, the change of direction associated with an eddy may alter the effective angle of attack with more result. This is greatest when the motion and the eddy are normal to one another: horizontal gusts on a windmill blade rotating in a vertical or near-vertical plane, or vertical gusts on a wing moving horizontally. A variant of the first type of anemometer was constructed which is constrained in its movement to a vertical plane and gives a record of the vertical component, or more correctly of $V\sqrt{\sin\phi}$ where ϕ is the instantaneous inclination of the wind from the horizontal. Fig. 3 shows simultaneous extracts from records taken in a fairly gusty 60 m.p.h. wind from this anemometer and from one of the normal type showing the horizontal variations. The vertical record shows that the instantaneous inclination of the wind does not exceed 2 deg. from the mean direction, and this is true throughout the record. The anemometers were mounted at the 88 ft. level of the mast but it is not known how much the hill smooths out the vertical fluctuations. The mean vertical component is probably due to a 1 deg. difference between the true horizontal and the zero of the instrument.

Institution of Naval Architects Spring Meeting (*continued from page* 526, *April* 26)

DESIGN OF A SHIP-MODEL TANK

Sir Stanley V. Goodall, K.C.B., C.B.E., took the chair at the opening of the second technical session, on Wednesday, March 27, of the 1957 Spring Meeting of the Institution of Naval Architects, when Dr. J. F. Allan, superintendent of the ship division of the National Physical Laboratory, presented his paper on "The National Physical Laboratory New Ship Hydrodynamics Laboratory." This paper was reprinted, with some abridgments, in ENGINEERING of April 19.

The discussion was opened by Mr. R. N. Newton, who remarked that, though the new establishment would cost some £2 million, this sum was only about one-third of one per cent. of the cost of the merchant ships built in the United Kingdom in 1956; and the saving in the fuel bill for a twin-screw motor ship of 19,000 tons gross that would be achieved in her life of 30 years by a 5 per cent. improvement in propulsive efficiency would be at least £600,000—a result that might well be attained by resistance and propulsion experiments costing no more than one half of one per cent. of that saving. Referring to the section of the paper dealing with wavemakers, he gave some particulars of the large amount of work required to evaluate the performance of the various types. The final design chosen for the manoeuvring tank at Haslar was of the plunger type, basically a 15 deg. wedge, with the angle increased in the upper portion to 25 deg. The need to produce cross waves was one of the principal factors which governed the final choice of plunger design. Tests carried out at Cambridge University indicated that the formation of these cross waves is a fundamental feature of the plunger itself rather than the tank configuration. The design of beaches had also made large demands on research effort and was attended by similar difficulties. At Haslar, 23 types of beach for the new manoeuvring tank were tried. The final design comprised two tiers of wooden slats, sloping back from just below the water surface to just above it. The beach was recessed into the wall of the tank and included a trap between the wall and the inner edges of the beach.

Dr. Allan had referred to the smallness of the manoeuvring tank, 100 ft. square, compared with the new tank at Haslar, which would be 400 ft. by 200 ft. It was a pity that the money could not be found for a larger tank, for the problem of accommodating the recording equipment, even in 20 ft. models, was difficult enough, and there was much to be said for using the same size model in the manoeuvring tank as in the ship tank.

Mr. C. L. Champion thought that the servo-mechanism of the wavemaker was probably unique in its combination of power, amplitude and frequency. Some experiments had been carried out with a purely hydraulic servo, which indicated that an electro-hydraulic link was required to obtain the desired accuracy. The actual forces between a wavemaker and the water seemed to agree quite well with the theory of Biesel, following earlier work by Havelock. In addition to the in-phase component corresponding to the energy put into the wave train, there was a large out-of-phase component which must be overcome; even a pneumatic wavemaker behaved as if it had considerable inertia. Some studies had been made for an adjustable hydraulic-pneumatic spring which would form a tuned system with the virtual mass of the wavemaker so that the driving ram need only supply the in-phase force; but as it proved possible to obtain a hydraulic pump with regenerative characteristics, that would provide a simpler solution. With reference to the cavitation tunnel: in 1949 a preliminary design was made for a resorber similar to that in California. When financial considerations stopped work, the Ministry of Works was requested to build a resorber for the Admiralty. It became apparent that, when the dimensions of a resorber were such as to prevent it being built in one piece, it was more economical to construct a circuit with sections not greatly exceeding 10 ft. in diameter, folded on itself several times. The new N.P.L. tunnel would be unique in having its working section rigidly anchored at ground level. The reduced diameter of the lower limb facilitated construction and made it possible to fabricate the inner tube without *in-situ* longitudinal welds.

Mr. W. A. Crago, referring to a tabulated list of existing tanks given in the paper, observed that one of the main characteristics specified was the length; but, as Dr. Allan had pointed out, the effective length at any given speed depended on the maximum carriage acceleration, the deceleration, the emergency stop, etc. A tank only 1,000 ft. long would be equivalent to the Feltham tank if the acceleration could be increased from 0·1g to 0·2g, equivalent to a saving of 300 ft.; thus a more significant characteristic to convey a tank's capabilities would be a curve showing test speed plotted against time or distance available at that speed. Such curves would show the advantage enjoyed by carriage systems where the towing motors were not carried on the carriage but at the end of the tank, an endless cable being used to transmit the drive. In that way not only was the carriage mass reduced, but wheel slip was eliminated. The effects of cable stretch could be reduced to negligible proportions by careful design, and the increased acceleration might well be obtained without increase of motor power because of the reduced carriage mass. At the Saunders-Roe establishment an acceleration of 0·2g was used in the 600 ft. tank to accelerate the carriage, dynamometers and personnel to top speed, but in the No. 2 tank, where the carriage was remotely operated, the acceleration could be taken up to 0·4g. The choice of a plunger type of wavemaker he believed to be correct. He had seen the pneumatic type at Delft and also models in this country, and at Berlin, and none of them could produce the regular smooth and big waves that the plunger form could. Was it proposed to install some device to produce an irregular sea, having any required components? Did not Dr. Allan agree that irregular sea tests, together with appropriate statistical analysis techniques, would soon replace regular sea tests?

Mr. John West, speaking as a representative of a shipowning company, welcomed the new ship model tank; with its additional facilities, there should be much more research work done, which was precisely what the shipowner required. Shipowners were not completely satisfied with the position they had reached. They wondered whether, with the higher-speed ships in the future, they might leave the screw propeller altogether and go to something new. Then there was the problem of stern design, and that

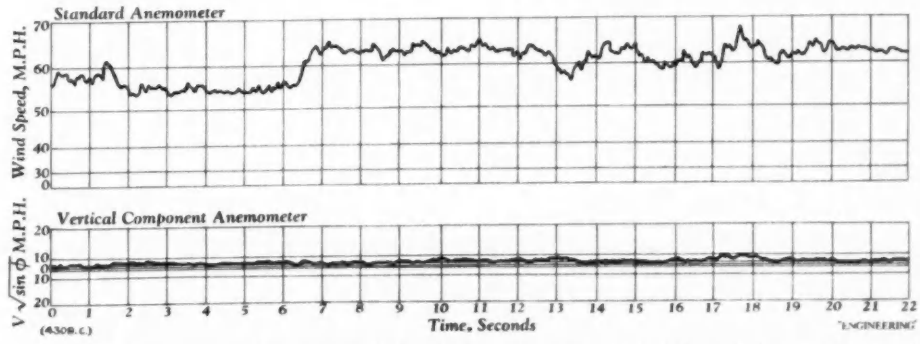


Fig. 3 Simultaneous records of standard horizontal gust anemometer and vertical component gust anemometer. The instantaneous inclination of the wind from the horizontal does not exceed 2 deg.

nightmare of a shipowner, stern vibration; and, in connection with passenger liners, there were always problems associated with sea-kindliness and pitch and roll. Also, quite often during the last couple of years, reference had been made to the submarine tanker, a project which would require a lot of research work. Shipowners were, or should be, more interested in ship model research. His own firm were building a 45,000 ton passenger liner; by improving the overall performance by a few per cent. they would save up to £7 million on the fuel bill during its life. That was a staggering figure, but it was a real one. In the future the shipowners must work more closely with the experimentalists and the tank superintendents, and obtain their advice right at the start.

Mr. P. R. Crewe, who, like Mr. Crago, was associated with the new Saunders-Roe tank, the smallest in Britain of those over 200 ft. long, while agreeing that large tanks were excellent for making routine approval tests on expensive shipping projects, regarded them as costly and time-consuming for research and development work. The Saunders-Roe ordinary ship model size, about 10 ft. long, was the same as that proposed for the free-running models in the new manoeuvring tank at Feltham. They had also a new radio-controlled model which could be tested at sea and came in the 10 to 12 ft. length. The employment of a continuous wavemaker in one wall of the manoeuvring tank and an articulated wavemaker in the other might seem strange but it appeared to provide a completely flexible system of wave production so far as direction was concerned if the model was making a complete turn.

The employment of continuous beaches in both side walls was interesting; they had found a continuous system along one wall to be invaluable. Would the double system damp out wakes so efficiently that very large models, in which the reflected bow wave would otherwise interfere with the stern, could be tested? Also, it seemed that the limitation of speed in the return run might prevent systematic investigation of high-speed behaviour in following seas.

Mr. H. Lackenby recalled that, in 1909, Sir Richard Glazebrook read a paper to the Institution in which he went very carefully into the problem of the maximum size of model that could be tested in the tank, concluding that the biggest was 16 ft. long, which was roughly half the 30 ft. width of the tank. Dr. Allan's paper showed that practically the same conclusion was reached in the case of the Feltham tank, that the biggest model they could test without side wall effect was 24 ft. long (half the 48 ft. width of the tank). Much had been said about tank boundary interference on models, and about interference in connection with ships. Some monster tankers would come along very shortly and before long the shallow-water effects and the restrictive effects on these ships going through narrow channels might be a problem. Had the committee in charge of the project considered the provision of special facilities for investigating shallow-water effects and the effects of restrictive boundaries generally? In the Lucy Ashton models in 1953, the value of the work on that set of geosims was greatly impaired by the fact that the larger models suffered rather badly from wall effect. He would be interested to see the Lucy Ashton models in the bigger tank; the 30 ft. model would be just clear of wall effect. He was also interested to see in the paper that, when the N.P.L. tank was provided in 1910, there was a circulating water channel 5 ft. wide by 3 ft. deep. When he was there in 1938 he did not see it. What had happened to it?

Dr. Allan: "It was dismantled when the water tunnel was built."

Professor E. V. Telfer said that about 12 years ago he was a member of the Froude Committee when the project of the Feltham tank first came out. Dr. F. H. Todd was given the task of visiting all the tanks of the maritime world and reporting back to the committee. He prepared an excellent report on the state of the art at the time, largely as the result of which they realised that, if for no other reason than keeping up British prestige, they had to have a new tank. Mr. West had said that even a few per cent. saving could amount to £7 million in the course of a ship's life. But assessing the commercial value of scientific work meant the acceptance of a position of contractual responsibility; it was just as easy to lose £7 million as to gain it. Dr. Allan appreciated the seriousness of that, and the need to establish that, beyond any possible doubt, the results obtained in the tank would be realised in practice. It was a problem which the tank experimenter had always avoided in public; but the avoidance could not be kept up for too long. Dr. Telfer was sure that ship correlation would be much more deeply and seriously considered as the result of the new tank, and that when Dr. Allan said there would be a saving of £7 million he could guarantee that the saving would be £10 million.

Dr. Allan, in reply to the discussion, said that he would deal with the various points raised in writing.

CAVITATION AND PROPELLER PERFORMANCE

The third paper presented at the Spring Meeting of the Institution of Naval Architects, on the "Effect of Cavitation on the Performance of a Series of 16 in. Model Propellers," by Dr. R. W. L. Gawn, C.B.E., and Professor L. C. Burrill, was a greatly condensed review of a programme of experimental work, carried out in the cavitation tunnel of the Department of Naval Architecture at King's College, Newcastle-upon-Tyne, which had extended over five years. It was presented by Professor Burrill, under whose supervision the work had been done, and summarised the results of tests with 30 propellers, made to the same design but having blade area ratios from 0·5 to 1·1 and face pitch ratios from 0·6 to 20. Each was tested at six cavitation numbers, over a wide range of slip. In all, some 3,000 tests were made, and about 1,600 cavitation photographs were taken. Professor Burrill mentioned that a full report would be available in due course in book form.

The basic propeller of the series (numbered KCA 110) was three-bladed and was designed with a constant face pitch ratio of 1·0, a blade area ratio of 0·80 and a blade thickness ratio of 0·045. The blade outline was elliptical and the sections were segmental over the outer half of the blade; at the inner radii the flat face was "washed back" at the leading and trailing edges. It was found that, with these wide and relatively thin blades, the torque diminished before the thrust under cavitation conditions; thrust began to decrease when cavitation had spread over about 15 per cent. of the blade.

Mr. A. F. Honnor said that, while the authors had presented their data with the minimum of diagrams, he found that the relative influence of the prime variables on thrust and efficiency under severe cavitating conditions was not readily ascertainable; therefore he had replotted some of the curves in a slightly different form. This analysis showed that the loss of thrust due to the development of back cavitation occurred at lower values of thrust parameter as the blade area was reduced and was not significantly altered by pitch ratio. Face cavitation was shown to be equally damaging at the lower pitch ratios and lower blade areas.

While both back and face cavitation could be reduced by suitable designs of the blade section, the trends derived from these data might be taken as generally applicable to propellers with a wide variety of section shapes. In view of the significance of blade area and pitch ratio with regard to face and back cavitation, he suggested that that aspect should be more exhaustively treated in the full report.

Mr. R. N. Newton explained that, though the series of tests in the paper might appear to be somewhat pedestrian, the Admiralty had decided that the propellers should be generally similar in blade section to those which formed the open water series reported by Dr. Gawn to the Institution in 1953. The object was to obtain an extension of that earlier series which would enable designers to take more accurate account of the effects of cavitation when analysing the trials of fast ships and applying the results to new vessels.

The information presented would achieve this object so far as constant-pitch segmental-section propellers for normal ship forms were concerned. He would warn the student, however, that these latest data should not be applied directly without application of factors derived from experience, because the full-scale flow conditions were very different from those in the cavitation tunnel. There was still a wide gap in the correlation of model results with those obtained at sea. There was scope for determining the influence of tunnel walls more definitely, both by theory and experiment. Attention was drawn at the Conference on Ship Hydrodynamics in 1954 to such factors as turbulence in the tunnel water ahead of the propeller, the effective area of the tunnel, non-uniformity of flow through the propeller disc, non-homogeneity of the fluid under heavily cavitating conditions, and Reynolds number effect. Had any such factors been taken into account in assessing the corrections? It might be asked what contribution the Admiralty Experiment Works had to offer in that connection. There was a possibility that experiments in the new and very large section cavitation tunnel, nearing completion, might enable a conclusion to be reached as to the size of propeller in relation to the area of a tunnel that could be used to avoid appreciable wall effect and scale effect.

Mr. A. Silverleaf welcomed the paper as being the first to give systematic results of propulsion experiments under cavitation conditions. Because this was the first, it was important that, if possible, they should agree upon and establish a system of analysis of the results and the form of presentation. On analysis, he would mention the method of correction, the use of the Wood and Harris channel momentum correction factors, which had been in use for some years. He hesitated to endorse Professor Burrill's statement that the aeronautical people accepted them; mathematically they did not apply under fully cavitating conditions. With regard to the presentation of results, alternative methods were clearly available. The form of presentation in the paper was a reasonable one, but it had some obvious disadvantages. Professor Burrill had said that the corrected atmospheric curves agreed well with the equivalent open water results. Could he give a few details of such comparisons? The comparison of the thrust breakdown factors for different blade area and pitch ratios should be exceptionally useful, but an even more useful comparison might be obtained by taking all the screws at varying blade area ratio, or alternatively a group of varying cavitation number and fixed blade area ratio. Lastly, in regard to the application of results, the authors had given an extremely valuable guide in their appendix, namely, to design exclusively for cavitation conditions.

Professor G. Aertssen considered that the results would be a valuable tool in the hands of all who had to design propellers, but asked if it would not be useful to correlate as often as possible the results obtained in the cavitation tunnel with the propulsion results at sea. That was possible when thrustmeters and torsionmeters were installed on a ship and careful readings were taken. A cross-channel ship, for instance, with a service speed of 20 knots, but which, with her full power of 12,000 s.h.p., could do more than 24 knots, did not want propellers which did not cavitate in the exceptional high speed conditions. Being designed, for instance, with a pitch ratio and a blade area ratio to give a good efficiency at 20 knots, they might cavitate, and probably did, at full power,

with a speed of more than 24 knots. Carefully conducted measured-mile trials, with measurement of power by torsionmeter and thrust by thrustmeter, would give, in such conditions, information which could usefully complete the work presented in the paper.

Mr. H. P. Rader said that he had recently tested three propellers with a blade area ratio of approximately 0·73, having different face camber ratios, but practically identical analysis pitch ratios and performance characteristics under non-cavitating conditions. The tests were carried out in the cavitation tunnel of Vosper Limited, Portsmouth. It appeared that, for each rate of advance or slip, there existed an optimum combination of pitch and camber, which would depend on the type of mean line and basic thickness form used and also on the blade area ratio. The superiority of the cambered sections was due to their higher lift coefficients, produced mainly by the pressure on the blade face. Higher lift coefficients meant lower drag lift ratio and higher blade element efficiencies. Propeller designers would appreciate it if the authors at some later date, or in their promised book, would give the lift coefficients and drag lift ratios; they would be of great value.

Professor E. V. Telfer criticised the authors' method of presenting their data. In his paper at the recent symposium on education he had said that one of the greatest troubles was how to improve the "putting-over" efficiency. The contents of a paper which had to be absorbed, more or less analysed, and eventually given to students, should be in a form which allowed the man who did the analysing to absorb it quickly, but it was impossible to do so with that paper. Various points of view had to be considered in deciding which was the best presentation to adopt. The numerical system adopted by Professor Burrill was unfortunate, because he himself was in a difficulty in not having a continuous system of digits to define a continuous system of blade area ratios.

In 1934, when Captain E. F. Eggert gave his first paper, a speaker claimed that he had been able to save a lot of power by eliminating face cavitation. At that time Captain Eggert said it was impossible for any efficiency improvement to result from eliminating face cavitation; but the present paper showed that it was possible and that there was a subtsantial gain in multiple screws by eliminating that cavitation.

Mr. W. A. Crago asked whether, if the data in the paper were used to design a propeller for a high-speed craft, what had been called the quasi propulsive coefficient factor, a factor particularly favoured by the Admiralty, became unity. The data in the paper took cavitation into account, and, as he understood it, the factor allowed for cavitation reached a value of 0·7 with motor torpedo-boats; in other words, there was a 30 per cent. discrepancy between what should be obtained from the propeller and what actually occurred during trials. The factor was equivalent algebraically to transmission loss. Did motor torpedo-boats suffer 30 per cent. transmission loss? He thought not.

Professor Burrill, replying briefly to the discussion, admitted that the paper presented a pedestrian and routine investigation of a very simple type of propeller; but, to use an Americanism, somebody had to do the "leg work," and when the research was undertaken there had been no leg work. Designers in the future would have something to go on. Regarding the tunnel wall correction, he made no excuse for the fact that the diagrams were corrected in that way. If necessary, they would publish in table form all the uncorrected results. Professor Telfer and others had said that the diagrams were not easy to follow. In summarising the results of five years' work in a short paper, something had to go, and they had tried simply to give the facts; the facts were there. Reference had been made to a "booklet" to be published later. It would not be a booklet, but a tome; it must be a large book to give all the information. Probably it would be a year before it appeared. He welcomed Professor Aertssen's remarks; there was no doubt that, under full-power conditions, the cross-channel ship must work in cavitation, and therefore, in time, they should have comparisons between ship and tunnel results. To give details of any comparison with full-scale work at the moment would involve dealing with Admiralty work.

SHIP MODEL EXPERIMENTS

The fourth paper presented to the Institution of Naval Architects at their Spring Meeting, on "Model Experiments on a Series of 0·70 Block Coefficient Forms," was in two parts, which were discussed together. Part I, by Mr. R. E. Blackwell and Mr. G. J. Goodrich, dealt with the effect on resistance and propulsion of variations in the position of the longitudinal centre of buoyancy, and Part II, by Mr. Blackwell and Mr. D. J. Doust, with the effect on resistance of variations in breadth-draught ratio and length-displacement ratio. The experiments in each case were carried out for the British Shipbuilding Research Association by the Ship Division of the National Physical Laboratory.

Five models were used for the experiments in Part I, the positions of the *LCB* ranging from 1 per cent. of the length between perpendiculars aft of amidship to 2 per cent. forward. Self-propulsion tests were carried out over a range of *LCB* from amidship to 2 per cent. of the length forward of that position, three propellers being used on each model to examine the effect of propeller diameter. The optimum position of the *LCB* was found to be approximately amidship, though the effect on the components of propulsive efficiency was not large. The effects of varying the propeller diameter and the speed were more marked, the highest values of the quasi-propulsive coefficient being obtained with the largest propeller at the lowest speeds. Placing the *LCB* at 0·02L forward gave the highest *QPC* values except for the largest propeller at the load draught. The delivered horse-power varied little with shift of *LCB* at normal ship speeds, but at the highest speed (16 knots) moving the *LCB* forward from the amidship position resulted in a large increase in delivered horse-power, amounting, at the 0·02L forward position, to 16 per cent. for all the propellers tested.

The tests recorded in Part II of the paper were made with nine models of merchant-ship form. In one group of tests the breadth-draught ratio was varied, the displacement and length being constant; in the other, the breadth-draught ratio was maintained constant and the length-displacement ratio was varied. The results showed that the effect of increasing the breadth-draught ratio above its value for the parent form (2·12) was to increase the resistance coefficient ("circular C") over the whole range of speed and at all draughts. Decreasing the length-displacement ratio increased the "circular C" at all draughts, the increment becoming greater as the length decreased from 400 ft. and as the speed-length ratio increased. In all the experiments, trip wires were fitted.

Mr. M. N. Parker, speaking on Part II of the paper, thought that the main idea of carrying out the tests at other than the medium and ballast draughts was to guard against somebody selecting a form on the basis of tests for the load draught only and then finding that it gave a poor performance in the lighter load conditions. He was surprised to find that it was apparently intended that the lighter-draught data should be used for determining the resistance of a different type of form. Admittedly, it appeared to be an abnormal form, and, he thought, would still be abnormal at the medium draught, when the cruiser stern was out of the water, and at the ballast draught, when the propeller aperture was coming out of the water; but there was already a similar series of 0·65 block coefficient forms with the same breadth-draught variations.

Mr. B. N. Baxter considered that the papers were very good from the design point of view, because they included in the diagrams not only the stern arrangements, but the correct shape of the propellers used, and the apertures. One of the conclusions from Part I was that the actual position of the *LCB*, ranging from 1 per cent. aft to 2 per cent. forward of amidship, had no effect on the resistance of the ship up to the values of $\frac{V}{\sqrt{L}} = 0{\cdot}7$. That value would give a speed of about 15 knots for the normal merchant ship, ranging from just over 400 ft. to just over 500 ft.

Professor E. V. Telfer suggested that the work described could be best appreciated, so far as centre of buoyancy influence was concerned, by considering the fore and after bodies separately and realising that, the fuller the fore body, the more rapid the increase in "circular C" at the higher speed value, but the lower it was at low speeds. In other words, a forward centre of buoyancy was obtained by having a full form forward, but it would result in a wake penalty. On the other hand, it automatically produced a fine form aft, with advantage at the low speed value. In some work that he was doing, a gradual accumulation of statistical matter, he had found it better to think solely in terms of the fore body and to introduce as a correction, not a percentage on buoyancy, but a correction solely for the relative fullness of the fore and after body.

In Part II the authors compared the Todd series 60 results with their own. He suggested that the series 60 models were more turbulent at the lower speed than the Teddington models. He would have liked to fit studs to that model, to see if he could repeat the Todd results more closely than they had. They had taken some credit that they could beat the Washington results at the slow speed; Dr. Telfer thought that was completely illusory and that the gain was due to eddying and could be explained by laminar flow. On the other hand, there was much more wavemaking with the Teddington model than with the Washington models. Sir Amos Ayre adopted as a standard a beam-draught ratio of 2, but it was easy to show that, in the general case, a beam-draught ratio of 2·7, where both beam and draught were unrestricted, was the most economical to use. Finally, he suggested that, in both cases, in addition to the details of the total "circular C" value, the authors should give a presentation of the skin friction part of the total "circular C," which would make it possible to refer from one presentation to another; that would effect a great saving of time.

Mr. Blackwell, replying to the discussion, said that the intention of the experiments was to predict trends and not actualities. The experiments were carried out on a particular form which was designed to be representative of modern practice, and variations were carried out on that particular form; the results of the experiments could be put down in a variety of ways, but the main point was that it was the penalty due to varying a particular parameter which was of particular interest in such an investigation. It was not intended that the data should be used for other forms; the experiments were made on a series of 0·70 block coefficient forms, and that was the basis. A draught variation was intended to be purely a draught variation; but if information was required about a particular set of form characteristics which might be given by one of the forms at a lighter draught, to get a close approximation to resistance, the data might well be used in that manner.

Mr. Doust, replying to Professor Telfer's suggestion that the difference in the two "Circular C" values was not due to form, said that, from the consistency of the data and various other factors, he was strongly of the opinion that the difference was not due to turbulent flow or to lack of it.

Reports of other papers and discussions at the I.N.A. meeting will be published in subsequent issues of ENGINEERING.

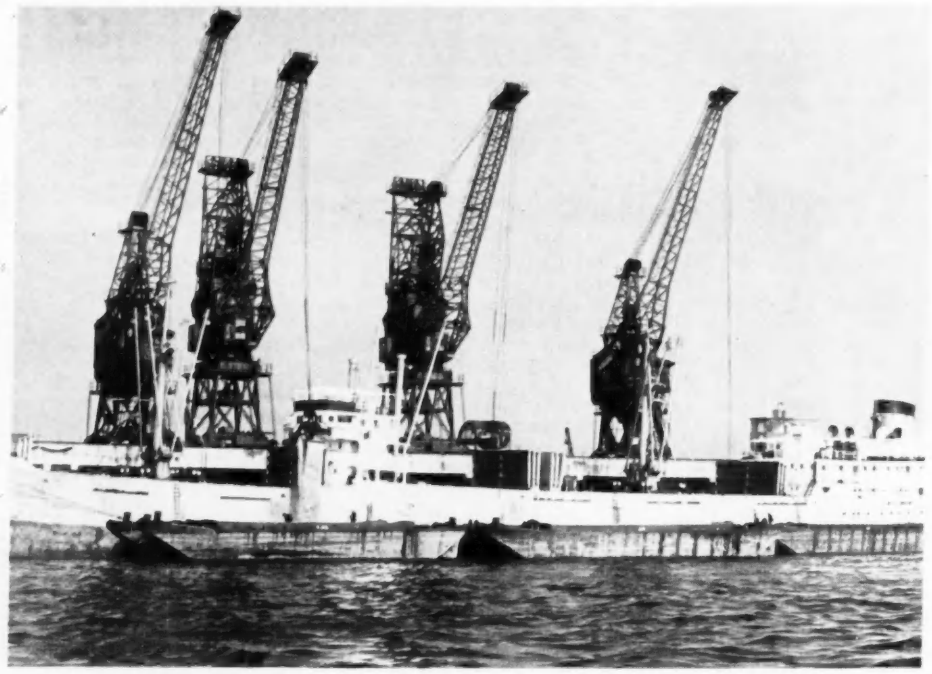


Fig. 1 Structural differences between the new (centre pair) grabbing cranes and the earlier models (outer pair) include the jib mounting. The cycle time for the new cranes when working to a barge lying outboard is about 26 seconds.

HIGH-SPEED GRABBING CRANES

DOCK INSTALLATION TO GIVE QUICK TURN-ROUND OF SHIPS

There were recently installed at Dagenham Dock by Samuel Williams and Sons, Limited, two 7½ ton grabbing cranes designed particularly for high-speed working and ease of operation. The two new cranes, which were constructed by Stothert and Pitt, Limited, Bath, are of the same capacity as those previously installed, to utilise the same grabs; but the cycle time when working from a ship to a barge lying out-board was required to be less than 28 seconds and the time when slewing through 150 deg. for working into a hopper was specified as 36 seconds.

Although the hoisting speed has been increased considerably, a substantial decrease in cycle time has also been made in reducing the accelerating and decelerating periods of the hoisting gear. This has been done by using steelworks auxiliary direct-current motors of low armature inertia. The motors were manufactured by the English Electric Company and are driven from Ward-Leonard generating sets. The mere fact of having low inertia was not sufficient to give the required speeds of cycles, and consequently field forcing has been applied to the generator by magnetic amplifiers, the control of which is taken from a potentiometer operated by the hoist controller. In this way the normal drawback of the balanced grab system, namely reduced acceleration during grab opening, no longer obtains. Full use has been taken of this advantage, and about half the weight of the grab contents, as well as the weight of the grab, has been balanced off. This has reduced the cost and enabled a smaller power hoist motor to be used. In fact, the nominal rating of the motors is 100 h.p. as against 200 h.p. in earlier cranes. An independent forced ventilation system is used to cool the hoist motor, and though the nominal speed is 485 r.p.m. at 230 volts a speed of 725 r.p.m. has been achieved by raising the armature voltage to 340 volts.

The motor-generator set, which is naturally ventilated, is mounted in an upstairs compartment of the machinery house, together with the electrical control gear. The generator has two separately-excited field windings connected with two resistances in diamond. Two magnetic amplifiers are used to supply the field windings, the circuit being arranged for the amplifiers to operate in push-pull. In this way the hoist motor is made to run in whichever direction is required, and in achieving this both amplifiers are used to best effect. The circuit is shown schematically in Fig. 3. Two bias windings are provided on the magnetic amplifiers to ensure that when the controller is in the zero speed position the outputs of the two amplifiers are matched. These biases require no adjustment after initial setting.

RAPID ACCELERATION

The cranes are 7½ ton rated capacity for grabbing duty at 85 ft. maximum radius, with a minimum radius of 25 ft., and a tail radius of 17 ft. 9 in. They have a total range of lift of 80 ft. plus the necessary grab pull-out of 23 ft. To achieve the specified cycles it was at first considered necessary to have a hoisting speed of 300 ft. per minute, and a lowering speed of 400 ft. per minute, but it has been found possible to increase both these speeds to about 450 ft. per minute without loss of control, and obtain still better cycle times. The particular attention paid to the rate of acceleration and deceleration of the hoisting gear has enabled an acceleration to 80 per cent. hoisting speed in one second, and change from full speed lowering to 80 per cent. hoisting in a little over two seconds, with full load on the crane to be achieved.

The slewing and luffing speeds were selected to suit the most frequently used working cycles, and are respectively 1½ r.p.m. and 175 ft. per minute average. Both these motions have a conventional alternating current drive, similar to the original cranes, but with contactor control gear operated by a combined miniature joy-stick master controller.

At the instant the hoist controller is moved from the zero speed position, maximum field forcing is applied to the generator, to overcome the machine time constant. A voltage feedback signal, derived from the generator armature, subsequently reduces the degree of field forcing as the generator voltage builds up. Rapid deceleration is achieved by regeneration and a solenoid-actuated mechanical brake is used only for holding purposes. This brake is applied automatically by voltage relays in the main armature circuit after the speed of the hoist has been reduced by regenerative braking literally to zero. This feature makes it possible to use a smaller size of brake than would otherwise be required. It also ensures that the life of the brake linings is considerably prolonged.

In view of the low inertia of the motor armature, the energy stored in it assumes roughly equal proportions to that of the low-speed hoisting barrel, the sheaves and the load itself. For this reason, the mechanical hoist brake has been placed, not on the motor shaft, but on an intermediate gear shaft between the motor and the hoisting barrel. This feature alone makes a substantial reduction in the total kinetic energy possible, the figure for the present equipment being approximately one-seventh that of the earlier cranes, measured at the same grab speed.

The hoist brake is of Elliston, Evans and Jackson manufacture, and has a 30 in. diameter drum running at 230 r.p.m. with a maximum braking torque of 6,000 lb.-ft. Some indication of the efficiency of the electrical regenerative braking system can be gauged from the brake drum temperature, which is only warm to the touch after a full day's work.

AVOIDING CLUTCH SHOCKS

The mechanical hoisting gear is of conventional two-barrel type with a coil clutch and hold brake, both being thruster operated under the control of a switch incorporated in the hoist master controller. In view of the very high speed of operation, and the large diameter barrels (4 ft.) it has been considered advisable to incorporate a device which prevents the clutch from being engaged when the hold barrel is at a standstill and the closing barrel running at

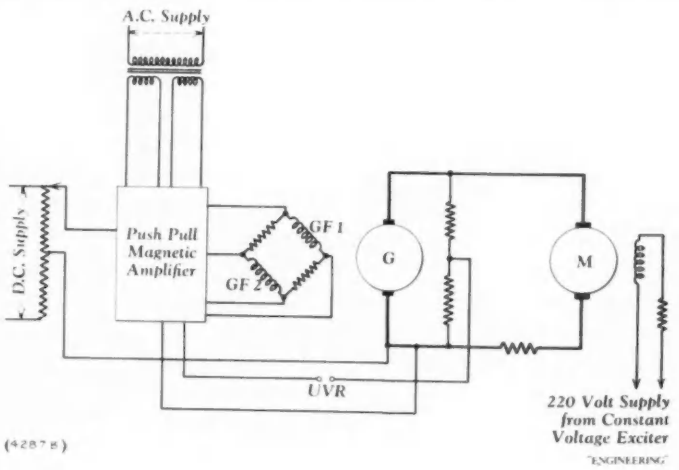


Fig. 2 The magnetic amplifiers supplying the generator field windings operate in push pull and so govern the direction of rotation of the hoist motor. Field forcing is used to improve acceleration.

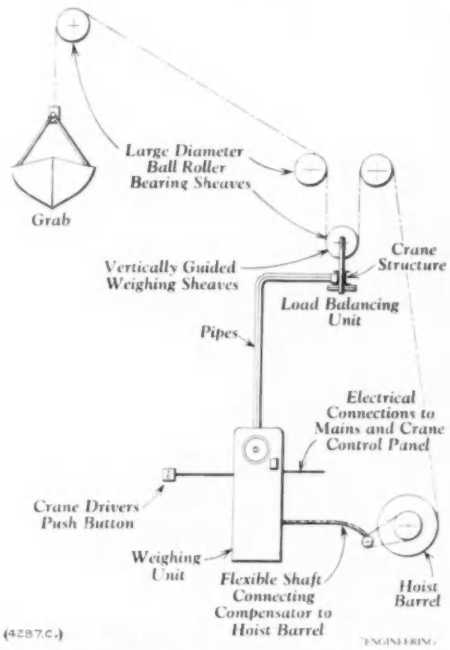


Fig. 3 Four seconds are sufficient to make a weighing of the load using the Williams hydraulic system.

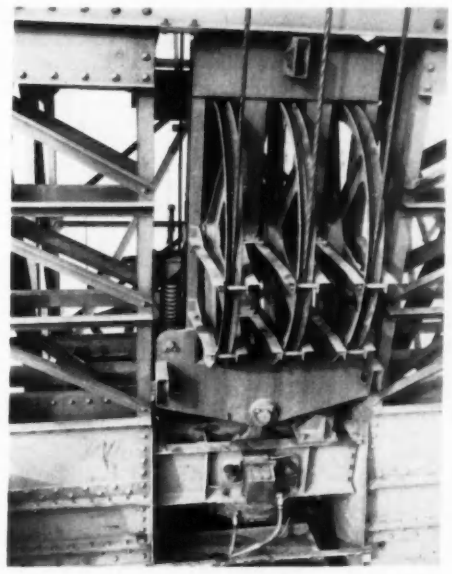


Fig. 4 The balancing cell takes the weight of the load as transmitted by the sheaves. Compensation is automatically made for the length of rope in use.

full speed. An electrical circuit has, therefore, been incorporated, which ensures that if the driver attempts to engage the clutch with the closing barrel running above 250 ft. per minute, full regenerative braking is applied and the clutch thruster operation is delayed until the speed has dropped below this figure. Full acceleration is then automatically switched in up to the speed dictated by the controller notch in use.

This arrangement has proved very successful, and the driver makes no attempt to slow up in practice, the slowing and accelerating being left in full control of the automatic equipment. Quite apart from protecting the clutch equipment, this also helps to reduce the snatch on the ropes. The driver is still able to disengage the clutch at full speed as this does not impose a shock on any mechanism, and is, in any case, an essential feature for a quick discharge of the grab.

Contrary to earlier practice, the jibs of the cranes are pivoted at the machinery bed level, and it was consequently necessary to bifurcate them, to enable a straight ahead view to be obtained. The difference between the old and the new types can be seen in Fig. 1. This change in jib mounting was chosen because of the change in method of luffing. By having a single-part reeving system over a high apex instead of the triple reeving of earlier types, a certain sacrifice of level luffing was incurred, but was more than offset by the economies obtained. The system, which can be seen in Fig. 1, shortens both closing and holding ropes by one-third and has the added advantage that the run-back of ropes from the jib to the barrel is less troublesome under slack rope conditions. The low pin position of the jib necessitated the use of a bell crank system for balancing, but whereas earlier Stothert and Pitt cranes using this system had single cranks and connecting rods in the centre of the cranes, the present machines have twin cranks and rods following conventional practice. The advantages of harmonic variation of luffing speed with radius and the automatic safeguard against over-luffing, are therefore retained.

IMPROVED ROPE LIFE

The general shape of the crane's superstructure was dictated by the desire to use the fewest possible reevings on the counterbalance weight ropes, and so enhance rope life. The arrangement adopted has a twin rope connection between the hoist barrel and the counterbalance weight with three reevings at the weight. The hoist barrel is extended to take the counterbalance ropes.

The actual runway for the sliding weight is inclined at a small angle to the vertical to eliminate undesirable rattling, the weight running on rollers on the track. A safety gear is incorporated in the weight to clamp it to the guides in the event of either or both of the ropes breaking.

To the right of the driver, who is seated, is an Allen West M.C. type miniature master controller, the handle being moved towards him for hoisting, and away for lowering. A slight sideways movement of the handle disenagages the hold barrel from the closing barrel and enables the hoisting and lowering movements to be converted to closing and opening movements respectively. To the left of the driver is a joy-stick Allen West M.C. controller, operating on slew and luff, the movement of the handle coinciding with the path of the grab.

CONVERSION FOR CARGO

Part of the original specification included a foot brake on the hoist motion, but after some experience had been obtained in using the cranes, it was discovered that the control afforded by the hoist mechanism was so excellent that the footbrake was never used, and it has been removed.

On occasions the cranes have to handle cargo, during which time the grabs are removed. As the requirments for cargo duty include creep speeds in both hoisting and lowering directions, in spite of large variations in load, a changeover switch has been fitted under the control of the driver. This switch enables him to select one of two hoisting conditions, namely, cargo or grabbing duty. With the switch in the grabbing position, the hoist controller has roughly equal increments in speed for each notch, and the electro-mechanical brake is under the automatic control of the voltage relays referred to above. With the switch in the cargo position, the voltage on the controlling potentiometer for the magnetic amplifiers is considerably reduced, and the magnetic brake is arranged to come on immediately the controller is brought to the Off position. This reduction in the potentiometer voltage has enabled very slow controlled creep speeds to be obtained (first notch speed being about 7 ft. per minute) with a maximum speed of 250 ft. per minute. These speeds are practically independent of load.

To the left of the driver is a foot-operated switch which frees the hold barrel brake when the clutch is disengaged and allows the grab to sink in the material when digging, without free hold rope being paid out in advance. The switch is only operative when the hoist controller is in the "Open/Close" position. In order that the hold rope shall be kept at a slight tension, a slipping clutch has been incorporated between the hold barrel and the close barrel.

All the cranes incorporate Williams Recording Weighers developed and marketed by Samuel Williams and Sons, Limited, the principle of which is shown in Fig. 3 and the balancing cell in Fig. 4. This machine automatically prints on a paper strip the totalised net weights discharged from the grab. Automatic compensation is incorporated in the equipment to allow for the variations in the weights of the ropes with hoisting and to deduct the tare weight of the grab. The only operation performed by the driver to obtain a weighing is to press a button. This locks the crane out for four seconds, which is long enough for the grab and crane to stabilise. Immediately after the weighing takes place, the crane is re-energised for work. No weighman is required, and the weighing equipment is in the driver's cab.

DIESEL SUPERCHARGING

In view of the growing interest in supercharging the smaller Diesel engine, the Symposium given at the Institution of Mechanical Engineers on April 9 on this subject, is very apposite. Four papers were included, the first dealing with the approach to the problem of pressure charging, the second with pressure charging by mechanically-driven compressors, the third with turbo-charging, and the fourth with the design and development of small radial flow turbo-chargers.

Mr. D. W. Tryhorn of the Gas Turbine Advisory Panel, British Internal Combustion Engine Research Association, was the author of the first, and in the course of it, he showed that the adiabatic efficiency of a compressor had a great influence on engine output. The well-known Rootes-type blower had several disadvantages, including a low efficiency, a considerable amount of noise generation and the difficulty of drive. To overcome these particular difficulties, the Bicera compressor was designed. Mr. Tryhorn discussed the effects of the relative efficiency of the types of blower and the effect that this had on actual engine performance. Speed was a problem, as the performance of the Rootes blower falls off rapidly at low speeds. The Bicera compressor in its prototype form would be suitable for pressure-charging engines in the 150 to 240 h.p. range, naturally aspirated, and a compressor, as distinct from a displacement machine, was essential if a satisfactory efficiency was to be obtained for delivery pressures above 7 lb. per sq. in.

For the Bicera compressor, which has been described in ENGINEERING, vol. 179, page 189 (1955), the charge is passed through two rotating lobes, and the port-opening period is capable of slight adjustment by the central tubular valve. In this way the output can be, to a certain extent, controlled. Mr. Tryhorn gave figures for performance of this compressor under various conditions, and after considering the turbo-charger, which he thought to be very inefficient for engines below 150 h.p., he drew the conclusion that with a compressor of a Bicera type, an increase in power of 50 per cent. in the middle speed range could easily be obtained.

CONSTANT POWER MACHINE

The author of the second paper was Mr. B. W. Millington, of Ricardo and Company Engineers (1927), Limited, Shoreham-by-Sea, and he indicated the practical achievements in the range of mechanically-driven compressors, with particular reference to the model developed by

Ricardo's (ENGINEERING vol. 180, page 424, 1955). He said that in the larger Diesel engines generally working over a relatively narrow speed range, the turbo-blower was in an unassailable position, but on an engine of capacity of less than ten litres, the gains in economy by using a turbo-blower became problematical, and great difficulty arose when a wide speed range was needed, and also when a high torque was required at the lower end of the speed scale.

The relationship between heat flux and gross fuel consumption encouraged the idea that a Diesel engine should be considered as a constant power machine, producing the same maximum horse-power at all speeds and burning fuel at the same rate at all speeds. To approach this, a high degree of supercharging at low speed was required, but only a little supercharge at full speed. This could best be achieved, in his opinion, by using a mechanically-driven supercharger. He again stressed the need for high adiabatic efficiency in a mechanically-driven charger system. One difficulty arose in the question of introducing a variable-speed drive for the supercharger, and this could be met in some degree either by balancing the torques required to drive the blower and the output shaft across a differential gear in the manner suggested by Glamann or, alternatively, by driving the charger from a separate power source, as was done in the Fell locomotive. Where direct drive was used, if an efficient means of controlling the amount of air delivered by the supercharger could be adopted, then the boost could be adjusted at all times to the requirement of the engine and an appreciable saving in work would result.

Mr. Millington then went on to describe the development of the Wellworthy-Ricardo wobble-plate supercharger, which was now in production. In the final model this had a very good adiabatic efficiency, and by adjusting the position of the rotary valves, some control of the output was possible. He quoted the results obtained using the 3½ litre supercharger, giving a boost pressure of 20 in. of mercury at the high speed range. The maximum useful torque was raised from about 110 lb. per sq. in. b.m.e.p. to at least 160 lb. per sq. in. b.m.e.p., and the area within a given constant economy contour was notably extended.

RECOVERING LOST ENERGY

The case for the turbo-charger was put forward by Mr. C. H. Bradbury of Simms Motor Units, Limited, East Finchley, London, in the third paper. He said that when compared with purely rotary prime movers, the Diesel engine was a mechanically inefficient piece of apparatus. About 20 lb. per sq. in. m.e.p. was normally lost in the process of driving the engine itself, before any useful power could be taken from the crankshaft. However, the exhaust gases possessed residual energy which increased when the engine was supercharged, and if, therefore, the supercharger could be driven from the exhaust gases, this energy would be at least partially recovered. In its earlier forms, the turbo-charged engine operated on an approximation to the constant pressure system, but later work had shown that higher efficiencies could be obtained by what was known as the "pulse system," in which the pressure waves occurring in the exhaust were utilised.

Two features which were largely unimportant in many industrial applications, but which were all important in road and rail vehicles, were those of torque and acceleration. In these respects the performance of a turbo-charged engine was not equal to that of an engine fitted with a mechanically-driven positive displacement blower. However, it was in the field of fuel economy that the turbo-charged engine showed to its greatest advantage. The development of the small turbo-charger had been held up by the fact that a component satisfactory on large or medium high-speed engines might not be equally satisfactory on smaller engines, and also, for a good form of construction, cost is not reduced in proportion to size. However, the advent of the inward flow rotor, and the possibilities thereby opened for lost-wax casting and minimum machining, had brought the small turbo-charger into the realm of commercial exploitation. The unit that had been developed by Simms-Eberspacher, (ENGINEERING, vol. 182, page 788), was then described by the author, and curves were quoted showing its performance under various conditions. After-cooling was one of the lessons that could be learnt from large engine practice, and Mr. Bradbury outlined the Miller and the Bone systems.

FUTURE CHANGES

Up to about 140 lb. per sq. in. b.m.e.p., dynamic and thermal engine loadings were not materially increased. Above this figure, however, it was necessary to investigate the stresses. High compression pressures were quite unnecessary as far as full-load operation was concerned, and a variable compression piston as developed by the British Internal Combustion Engine Research Association, could look after this problem. A second problem occurred with the time taken to inject the fuel. More fuel was required as more power was delivered, and therefore the rate of injection had to be increased without increasing the pump drive loading. Mr. Bradbury then made reference to a servo-operated fuel injection system also developed by Bicera.

Regarding the future, he considered the possibility that engines could be fitted with turbo-chargers having compression ratios up to 4 to 1. As considered opinions, he thought that with a compression ratio of 4 to 1, a rating of 360 lb. per sq. in. b.m.e.p. would be possible with a brake thermal efficiency of 35 per cent. However, at this ratio a maximum cylinder pressure of about 1,500 lb. per sq. in. would be required. For high pressure ratios, the pulse system would be discarded and valve overlap reduced to a minimum. Pistons would not present undue difficulty as far as temperature was concerned, but present-day ring layouts would require modification. The fuel injection system would either be servo-operated or of the common rail type. However, when pressure ratios of 4 to 1 had been reached, the engine was unlikely to remain in its present form, and might well become a gas-generator, crank-shaft controlled, with a free-running turbine as a power unit after the turbo-charger.

AXIAL OR RADIAL

Problems involved in the design of small radial-flow turbo-chargers were considered in the fourth paper, which was presented by Mr. C. A. Judson and Mr. E. Kellett, both of the B.S.A. Group Research, Birmingham Small Arms Company, Limited, Small Heath, Birmingham, 11. They said that there was a definite economic minimum where the gains from turbo-charging of existing designs could be off-set by the use of a slightly larger naturally-aspirated engine, the increase in engine cost being less than the first cost of a turbo-charger. This size was probably somewhere just under 80 b.h.p. For engines in the 100 to 300 h.p. class there were considerable gains to be obtained by turbo-charging. From the stand-point of performance, the axial-flow turbine tended to lose its advantage to the radial-flow turbine as the size was reduced, and the "break-even" point would seem to be somewhere about the 600 to 700 h.p. group for a compression ratio of 2 to 1.

High speeds were inevitably connected with the turbo-charger, and rotational speeds of the order of 40,000 to 50,000 r.p.m. would seem to give optimum performance. At these speeds a number of new design problems occurred, in particular, the location of the rotors to the shaft became extremely important, owing to the centrifugal forces induced. To obtain the quickest response to changes in engine fuelling, the rotating assembly must be kept as light as possible. Matching was another important aspect, and when correct matching had been achieved, the engine operation lines should pass through the maximum efficiency contours of the compressor. Characteristics could be varied both by adjustment of the nozzle ring and choice of depth of the rotor.

The authors described the development difficulties encountered in producing their turbine and compressor, and also the methods of driving and testing the various components. The complete equipments were tried out on self-running high speed rigs, but the final development was done on actual engines. Performance curves for this were quoted. The turbo-charger lent itself to permanent-mould casting techniques, and pressure-die castings were favoured for many of the parts, to avoid laborious machining. The investment casting process had been used and was found to be satisfactory. Balancing of the completed rotor was extremely important. The initial development on the radial-flow turbo-charger had been on a pressure ratio of 1·5 to 1, which seemed to meet the requirements of most existing and newly-designed engines. Developments in radial-flow turbines indicated that they could well compete with axial-flow types up to power outputs of at least 600 h.p.

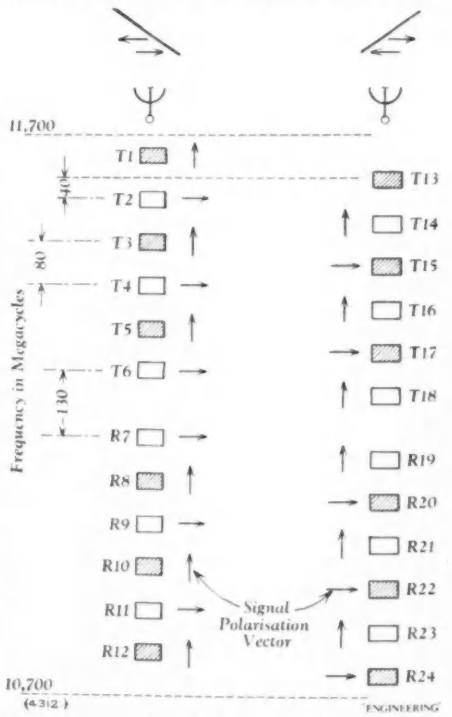
★ ★ ★

DUAL POLARISATION IN MICROWAVE SYSTEM

To provide a reliable but inexpensive short-distance microwave relay system, Bell Telephone Laboratories, New York, have developed the, "TJ" system which provides up to six broad-band channels, on the same route, in each direction of transmission. Each channel can accommodate either a telephone or a television service. The equipment operates at 11,000 Mc/s.

A feature of the equipment is the manner in which different angles of polarisation are used to reduce interference between adjacent channels. A single aerial is used in each direction for simultaneous transmission and reception. The aerial is a paraboloid and is fed by a circular waveguide. To keep the length of the waveguide short, and so reduce losses, the 5 ft. paraboloidal dish is mounted vertically close to the transmitter, and its vertical beam of radiation is reflected horizontally to the distant station by means of a plane reflector mounted at the top of a tower.

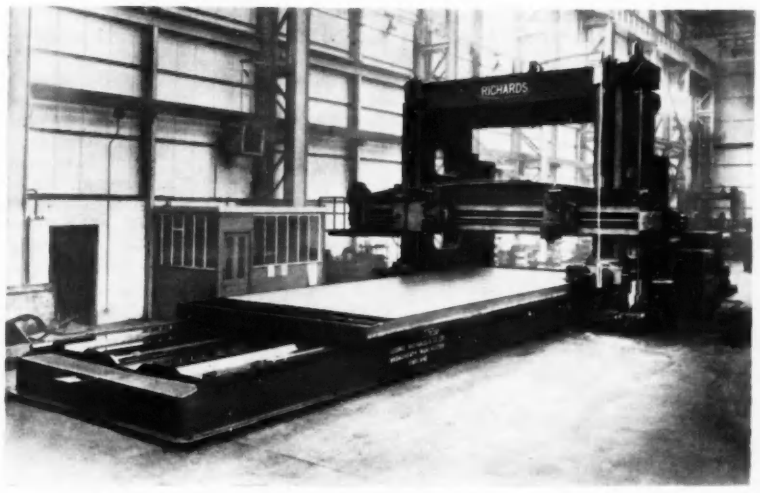
The accompanying illustration shows the manner in which the various channels are spaced



This diagram shows the manner in which the polarisation vectors are distributed among the channels being transmitted (T) and those being received (R).

and the way that the polarisation vectors are arranged. It will be remembered that the familiar " H " aerial of television is an example of a singly polarised aerial, the plane of polarisation being the plane of the " H." Since the paraboloids of the " TJ " system are symmetrical it is necessary to polarise the waves before they reach the aerial. The polarised waves originate from a klystron and rectangular waveguide. The latter is connected to the circular waveguide by a polarisation separation network. Reflections of the waves in these systems could cause serious distortion, and to avoid this a ferrite isolator is used which consists of two critically-spaced slabs of magnetised ferrite installed in the connecting waveguide. The direct signal passes through this isolator with about 15 per cent. loss. The reflected signal is attenuated by a factor of about a million.

By ensuring that the polarisation vectors of adjacent channels are at 90 deg. to each other, an additional discrimination of 25 db is achieved. Each of the channels is 20 Mc/s wide and the channel separation in a given direction is 80 Mc/s. The normal signal at the receiver is such that the system can operate through fades of as much as 40 db. This fading margin will take care of the attenuation in the 11 kMc/s band due to absorption and scattering of microwaves by raindrops during severe rainstorms.



Cross planing and surface grinding can be carried out on this Richards 30 ft. by 14 ft. by 10 ft. machine, in addition to normal longitudinal planing.

The machine is driven from a Ward-Leonard set, and has a counter-balanced cross slide.

PLANING AND GRINDING

LARGE-CAPACITY MACHINE WITH DETACHABLE HEADS

Built by George Richards and Company, Limited, Broadheath, Altrincham, Cheshire, to the order of William Asquith, Limited, the heavy-duty planing machine illustrated herewith is capable of machining work up to 14 ft. wide, 10 ft. high, and 30 ft. long. It is arranged to carry out cross planing, deep cross planing and surface grinding in addition to normal longitudinal planing; detachable heads are provided for the extra operations.

The box-section bed of the machine is 11 ft. 6 in. wide and has four slideways, each 60 ft. long. Lubrication of the slides and the main drive worm box in the centre of the bed is by two motor-driven oil pumps, drawing oil from a sump in the machine bed. Surplus oil from the slides passes to sumps at each end of the machine. Electrical interlocks prevent the main motor from being started unless the oil pumps are running.

The machine is driven by a Metropolitan-Vickers Ward-Leonard set and an 80 h.p. reversing variable-speed direct-current motor. Cutting and return strokes are controlled by independent rheostats, giving a range of speeds from 10 to 130 ft. per minute in both directions. The main motor is at the side of the machine parallel with the table, and is connected through a flexible coupling to a worm reduction box which drives the oblique spiral pinion shaft under the table. A nickel-chrome cast iron rack on the underside of the table meshes with the spiral pinion, thrust being taken by heavy-duty double ball thrust washers.

FOUR TOOL BOXES

There are two tool boxes on the cross slide, and these have hand, automatic and rapid power-traverse both vertically and horizontally. Angular adjustment is also provided by means of a worm and quadrant. A side tool box is fitted to each upright, and these have automatic feed and rapid power-traverse vertically, and hand adjustment horizontally. Feed and power-traverse motions, which are interlocked to prevent simultaneous engagement, are taken from a 9 h.p. motor which also powers the cross slide elevating motion. The feed boxes give a range of fine feeds from $\frac{1}{96}$ in. to $\frac{1}{4}$ in., and a coarse range from $\frac{1}{32}$ in. to $\frac{3}{4}$ in. per stroke of the table to the cross slide boxes horizontally and the side boxes vertically. The feed ranges to the cross slide boxes vertically are half those provided horizontally. The coarse feed range also applies to the cross slide vertically. Solenoids are fitted for lifting the tools on the return stroke, and they are so wired that should the table stop-button be pressed during the return stroke, they remain energised, thereby preventing damage to the tool or work-piece.

BALANCED CROSS SLIDE

The cross slide, which is extremely rigid, is counterbalanced by weights and cables. It is locked in the required position on the uprights by means of two $\frac{3}{4}$ h.p. motors, which drive, through gearing, two clamp plates bearing on the inner square lock of the upright, one at the top and the other at the bottom. The motors are push-button controlled, and are interlocked with the main driving motor to prevent the table being put in motion while the cross slide is unlocked. Interlocking is also provided between the locking motors and the motor powering the elevating mechanism; limit switches are fitted to prevent overrun of the slide and the side tool boxes, and to prevent collision between the cross slide and side tool boxes.

The left-hand planing head is mounted on a long saddle, and a detachable cross planing head can be mounted on this saddle, giving a cross planing stroke of 12 ft. 9 in. from the inside face of the left-hand upright. Motive power is provided by a 15 h.p. motor mounted on the back of the cross slide and transmitted through a driving gearbox and a screw in the cross slide which engages nuts on the saddle. The length of the stroke is controlled by a large dial with adjustable dogs and a reversing switch. An electrical interlock provides for the operation of the longitudinal planing motion, with reversal controlled by adjustable dogs on the table, or of the cross motion controlled from the dial; the two cannot be engaged simultaneously. Feeds to the cross planing head are provided by the feed box used for longitudinal planing, the feeds for both motions being the same. Tool lifting for the return stroke is by solenoid, the arrangement being similar to those on the longitudinal heads.

The counterbalancing of the cross slide, which is a new feature on a Richards planing machine, has been incorporated primarily to steady the slide as it commences deep cross planing. For this operation the tool box on the cross planing attachment is swivelled through 90 deg. from the vertical position.

SURFACE GRINDING

The right-hand planing head can be removed and a Snow grinding head with a 20 in. diameter wheel can be fitted in its place by means of an adaptor plate. This unit is self-contained. A coolant system is provided for use when the grinding head is fitted, coolant being drawn from tanks through filters and returned to the tanks by means of the trays and drain on the table.

A floor mounting cubicle houses the main control and feed contactors, and the rheostats are arranged in a panel at the side of the main planer column, adjacent to the operator's normal working position. Push-buttons on the rheostat panel control the " raise " and " lower " motions on the cross slide elevating motor, " lock " and " unlock " on the cross slide locking motors, and " start " and " stop " on the oil pump motor. In addition there are " on " and " off " switches for each of the tool box solenoids, " MG set " and " longitudinals " or " cross planing " selection. Indicator lamps and dials giving cutting and return speeds for both longitudinal and cross planing are also mounted on this panel. A twelve-point, pendant, counter-balanced push-button station for controlling the machine movements is suspended from the top of the main columns.

Book Reviews

SKILFUL MANAGEMENT IN THE LAB

Laboratory Administration. By E. S. Hiscocks. *Macmillan and Company, Limited, St. Martin's-street, London, W.C.2.* (36*s*.)

During the past fifty years scientific research has been an expanding industry. New fundamental discoveries have steadily outpaced their productive applications and the corresponding growth of research establishments is an outstanding feature of the times. The expenditure involved, both in money and manpower, is already great enough to justify almost stringent control to ensure that so important an investment shall yield the highest possible return. On the other hand, it is traditional for a scientist to be a dedicated individualist, resenting formal organisation or management and inclined to regard administration, beyond the provision of laboratories and equipment, as a needless, if not positively detrimental, interference with his life's vocation.

The task of reconciling these conflicting requirements could hardly be in better hands than those of Mr. Hiscocks. In the first place, his personal experience covers both points of view. He has been, in turn, a research scientist, a scientific adviser to administrators, and, in his present post, of secretary at the National Physical Laboratory, a senior administrator. At that laboratory, it may be mentioned, the work ranges from fundamental research to testing, covering many branches of physical science, and the staff embraces every adult age group. In the second place, Mr. Hiscocks has made a close study of laboratory administration over many years, not only from the published literature on the subject, but, perhaps more valuable, from visits to industrial and foreign research establishments and discussions with their staffs. The author's many references to the opinions and practices of other administrators, and to the conclusions expressed in books and reports of research surveys, in no way detract from the authority of his own views. Indeed, on the contrary, they have obviously contributed to his broad outlook on a subject on which there exists marked diversity of sincere belief, while, at the same time, providing him with opportunities for liberal and constructive criticism on the more controversial aspects of research administration.

It must not be inferred, however, that Mr. Hiscocks has been able, in a single book, to explore and pronounce on every problem or combination of circumstances that may confront some administrator at some time. His main theme for example, is the management of laboratories having staffs of at least two hundred people, and he has not attempted to cover such matters as the choice of the research objective or higher policy-making, except in so far as they affect the day-to-day running of the establishment. Also outside his scope, no doubt deliberately and wisely, is any consideration of political or ethical questions that have already arisen in administered research and may be expected to recur. One other general feature of the book that will be especially noticed and perhaps deplored by senior members of the research organisations of commercial bodies is the high proportion of attention, in the way of illustrative practices and statistical information, paid to the scientific Civil Service. In fairness to an author who is himself a distinguished member of that service, it can be asserted that his critical discrimination extends to the imperfections no less than to the merits of the sort of administration with which he is intimately concerned, so that his most constructive conclusions will bear a very wide interpretation.

Within these limitations, Mr. Hiscocks presents an admirably comprehensive treatise on laboratory management, introduced by a general survey of the factors that are peculiar to a scientific administration. A whole chapter is devoted to the head of the establishment, for whom somewhat different requirements are postulated, according to the size of the organisation and the type of research being conducted. The moot point, as to whether a director should be primarily an administrator, or a scientist of such eminence that his leadership is accepted by all those who work under him, supplies ample material for a thought-provoking, if somewhat indeterminate, discussion, leading up to the suggestion that professional science administrators will be trained, in the course of time, to hold a harmonious balance between the two types of qualification. The last chapter in the book amplifies the author's opinions on the value of management training courses in relation to research administration, and particularises the trends of British and American practice in such matters.

In the meantime, the administrative problems presented by laboratory staffs have been considered in great detail, from the standpoints of training, recruitment, remuneration, grading, and the optimum ratio of scientific to industrial and office workers, and consideration given to the attitude of administrations towards staff welfare and professional organisations or trade unions. The important part played by administration in promulgating the flow of information to and from a research laboratory is instructively dealt with, attention being given to desirable policies as regards patents and copyright, technical and office services, and the encouragement of inter-departmental conferences and social activities common to the staffs of the several laboratories comprising a major research organisation. The financial responsibilities of administration are discussed at length, though less in relation to the technical accountancy practice of a laboratory than to the more controversial matters associated with the administrative control of research programmes, costing systems and the monetary evaluation of experimental work. A chapter in the book on the design, maintenance and servicing of laboratory buildings is commendable for its emphasis on the advantages of structural flexibility and professional architecture. The author's recommendations may sometimes read like counsels of perfection, but, at least, they provide a standard at which the small industrial laboratory administrator can aim.

To describe the book as the best of its kind so far produced by an English author is rather faint praise, because administration, as a productive element of scientific research, has gained recognition too recently for comparable studies of equal scope to have been published. It is more to the point to admit that Mr. Hiscocks will convert most of his readers to his own belief, that skilful management has a positive part to play in the expansion of scientific knowledge and that it may prove to be one of the most effective contributions to the future growth of such knowledge. Among the converts, there will be many scientists and laboratory workers who have hitherto been suspicious of administration on principle. They, especially, will regard his arguments as the more impressive on account of the cogent writing in which they are presented and his understanding of the scientist's outlook. Most of all, perhaps, they will appreciate Mr. Hiscocks's own conviction that a readiness to experiment in methods of research management is more sensible, at this stage, than premature attempts to formulate enduring laws. This book should do a great deal to promote that mutual understanding and co-operation without which no form of administration, however benevolent, can be completely successful.

HUMAN NATURE

The Role of the Personnel Officer: A Group Review. By Guy Hunter. Occasional Papers No. 12. *Institute of Personnel Management, 8 Hill-street, London, W.1.* (4*s*.)

Between the wars the personnel officers were fighting what was often a thankless battle for the recognition of their function against the hostility of managers and trade unionists alike; during the last war their services were sometimes considered the panacea for all the ills in the industrial body politic and to-day there can hardly be an industrial firm in which the personnel function is not performed in a recognisable way by someone.

Nevertheless this recognition has not been achieved without much grumbling on the part of managers and supervisory staff and even in the House of Commons a miner member was recently heard to say that he did not want personnel officers to assist that grossly overworked man—the mine manager. Neither manager nor technician, poised delicately on the tight-rope between "Line" and "Staff," the personnel officer in the past has sometimes taken refuge in attitudes of moral superiority to the hard-headed and hard-hearted men who were responsible for output.

The Institute of Personnel Management contains among its members a number of very intelligent and sincere men and women, and it is to their credit that a group of them should have sat down and thrashed out the ideas in this very honest little pamphlet. Their conclusions start by discarding the idea, propagated by some sociologists, that industrial activity can somehow be integrated with the rest of social life, but agree that the role of industry is simply to meet the economic needs of Society. This refutes completely the idea that it is an employer's job to play the social reformer or to attempt to "improve" his employees by benevolent paternalism. The personnel officer is as concerned with the economic efficiency of the enterprise in which he works as the rest of the management team; although it is particularly his job to weigh the economic need of the moment against the employees' basic rights and current ideas of social morality. In doing so he is not acting by higher standards than those of good management as a whole; but simply as a remembrancer to his colleagues of the moral elements involved.

The group did not quite agree as to whether the personnel officer ought to stand in a special relationship of confidence between employees and general management, with the implication that he is in a professional relationship with the firm; but came to the conclusion that the case for strict professionalism is not at present made out and that he is probably best incorporated firmly in the management team.

One of the most controversial conclusions to which the majority of the group came was that the personnel officer should act as a principal negotiator with the trade unions. This seemed to arise from an attempt to fall over backwards to take on the unpopular "dirty work" of the business; but it is strange that no reference is made to the extreme unwillingness of trade union officials to conduct wage negotiations with officials without authority to settle. It may be that the group had in mind their recommendation that someone responsible for the personnel function should be on the board, in which case no doubt he would be the firm's negotiator; but if this is not the intention then the procedure of negotiation needs spelling out much more carefully if it is not to be misunderstood.

The group recognised the great change in the social and political climate since the Institute was founded and cast a slightly jaundiced middle-class eye forward to the time when they will be more concerned with the salary differentials of the technicians of the electronic age and of the growing ranks of junior and middle management, including their own, than with those of the manual workers. Here they recognised they were verging into the field of those political conflicts which are based on the intergroup

tensions within the community and which, as one of their members expressed it, are better fought out, not on an industrial background, but within the political or other more appropriate regions of our national life. It is the belief of this group that it is the job of the personnel officer, in the advice he gives to management, to work for a quality of human relationship in industry richer and more human than the cash nexus and his recommendations must therefore be based on a philosophy of human society and of human nature to which his deepest thought has been given.

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NEW BOOKS

Aircraft Gas Turbines. By C. W. SMITH. *John Wiley and Sons, Incorporated*, 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (8.50 dols.); *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.2.* (70*s.*)

The book concentrates on the fundamental principles of the aircraft gas-turbine plant, and supplies information on the design of components, the calculation, analysis and production of performance, and the character of test results. In the book the practice of expressing equations in terms of the isentropic factor, x, has been adopted, which results in considerable simplification of equations and greater ease of calculation. This work is one of a series written for the General Electric Company of America.

Basic Technical Drawing. By H. C. SPENCER. *The Macmillan Company*, 60 *Fifth-avenue, New York* 11, *N.Y., U.S.A.* (4.32 dols.); and *The Macmillan Company* (*New York*), 10 *South Audley-street, London, W.*1. (30*s.* 3*d.*)

As its name implies, this volume starts with the very elementary learning of drawing dealing with the methods of sketching, mechanical drawing, and lettering; it then passes to methods of drawing specific lines such as tangents, and then to different views of objects. Later come the drawing of specific items such as threads, fasteners, followed by working pictorial drawings and finishing with a section on map draughting. The author has set out to make the book as nearly self-teaching as possible.

Random Processes in Automatic Control. By J. HALCOMBE LANING and RICHARD H. BATTIN. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (10 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.4.* (75*s.*)

The first part considers the basic concepts of probability and random time functions which are then used to develop analysis and design techniques for linear control systems. Special emphasis is given to the non-stationary problem, and the use of analogue computing machines to provide feasible solutions for such problems. The book is intended to provide a practical engineer and theoretical research scientist with a basic research background in the theory of random signals and noise, together with practical techniques to be used in the analysis and synthesis of linear control systems.

Frequency Response. Edited by RUFUS OLDENBURGER. *The Macmillan Company*, 60 *Fifth-avenue, New York* 11, *N.Y., U.S.A.* (7.50 dols.); and *The Macmillan Company*, (*New York*), 10 *South Audley-street, London, W.*1. (52*s.* 6*d.*)

The articles in this book are intended to cover a wide range of interests from those of the beginner to those of the expert on frequency response. The book is divided into nine parts, starting with fundamentals, and proceeding to deal in turn with frequency response aids, servos and power plant, power applications, process control, transient response, non-linear techniques and statistical methods, and the like. Each section has articles written by experts in the particular field. Together they make up the papers and addresses presented at the 1953 A.S.M.E. Frequency Response Symposium, to which ten articles have been added. There is also a large bibliography.

Symposium on Steam Quality. Presented at the Fifty-ninth Annual Meeting, American Society for Testing Materials. A.S.T.M. Special Technical Publication No. 192. *American Society for Testing Materials*, 1916 *Race-street, Philadelphia* 3, *Pennsylvania, U.S.A.* (1.75 dols.)

Four papers were presented at the symposium, dealing with measurement and purification; purity determination by tracer techniques; conductivity measurements; and Larson-Lane purity and condensate analysers. The discussions which followed the presentation of the papers are included.

KEEPING COUNT OF MICROSCOPIC PARTICLES

A device for counting and sizing microscopic particles has been produced by Mullard, Limited, Torrington place, London, W.C.1. Capable of analysing both electron micrographs and photomicrographs, the device counts the number of particles above a predetermined size that appear in a specimen. Particle size is an important factor in the production of such things as paint, steel, chocolate, and photographic films. In the field of medicine, blood-cell counting is a routine requirement. In mining and atomic energy establishments the dust content of the air is the subject of analysis for health physicists.

The film scanning particle analyser—as the device is called—displays the magnified image of the film being analysed on the screen of a 12 in. cathode-ray tube on its front panel, shown in the illustration. The size of particle above which a count is to be made is set by a control and the count is registered on a dekatron display. So that the operator can know how the machine is selecting particles for counting, a particle is tagged on the screen with a spot of light each time it is counted. In the illustration it is clear that the machine has been set to count all of the particles present. The tagging also serves as a check that a particle is not counted more than once.

A magnified image of particles of pigment appears on the cathode ray tube. The pattern traversed by the scanning spot can be seen, as can the light "tags" which indicate whether a particle has been counted.

The 35 mm. film record of the particle sample is scanned by an electronic flying-spot system (a description of this technique is given in more detail in ENGINEERING, March 15, 1957, page 348). Each time the scanning spot traverses the image of a particle the signal obtained is compared with that which was produced at the same distance along the previous line of scan. If the particle has not intercepted the previous line of scan then it is being encountered for the first time and a count pulse is produced. Conversely, if the previous scan was intercepted then no further count pulses occur. In this manner one count pulse is produced for each particle. Signals to enable the comparison of the previous line with that being scanned are obtained by use of a delay-line "memory" which remembers the events occurring as the spot travels the line.

Sizing is achieved by measuring the time it takes for the spot of light to traverse the particle image. A control circuit ensures that, for any given setting of the sizing control, a certain duration of traverse must be attained before the particle is counted. The image area of the film is covered by 100 traverses of the light spot in 0·1 of a second. To record a count the pulses produced by the particles are automatically registered by a decade counter for the period taken to count ten frames (one second).

To illustrate the behaviour of the instrument, typical results are given in the table. The readings were taken on a sample of pigment. The particles were of an irregular shape and had a fairly wide size distribution. A magnification of 500 was used in the microscope. Ten size analyses were made on the sample, and the various numbers of particles recorded in each size range have been used to calculate the coefficient of variation for that range. It will be noticed that in general the individual coefficients increase in the ranges where there are comparatively few particles. But in the size ranges of most interest the coefficients are less than 3 per cent.

The average variance (V') of these results has been calculated from the individual variances (V_1, V_2, V_3, etc.), using the formula

$$V' = \frac{(n_1 - 1)\,V_1 + (n_2 - 1)\,V_2 + \ldots .}{n_1 + n_2 + \ldots . - 2}$$

where n_1, n_2, etc., are the numbers of particles in the various size ranges. In this instance the average variance $V' = 4{\cdot}94$. Consequently, the average standard deviation ($\sqrt{V'}$) is 2·22.

The average coefficient of variation (v'), based on the numbers of particles in the various size ranges, is therefore given by

$$v' = \frac{2{\cdot}22}{94{\cdot}3} \times 100 = 2{\cdot}35 \text{ per cent.}$$

TABLE.—TYPICAL RESULTS OBTAINED WITH ANALYSER TYPE L.188 BY TAKING 10 READINGS AT EACH OF 10 PARTICLE SIZE RANGES

Upper limits of size ranges in millimeters	0·20	0·28	0·39	0·56	0·80	1·13	1·60	2·28	3·23	4·60	Analysis No.
Number of particles counted by analyser	306·6	267·4	166·4	96·3	57·1	31·9	13·0	4·9	2·6	1·0	1
	301·9	270·3	169·8	99·7	53·9	31·7	12·4	4·7	2·3	1·0	2
	298·4	271·5	166·6	98·4	54·5	31·7	11·2	4·9	2·3	1·0	3
	307·5	269·5	168·1	97·6	58·3	33·3	13·3	4·6	2·3	0·9	4
	304·8	270·5	163·8	101·1	57·1	30·6	12·1	4·6	2·1	0·9	5
	303·3	269·2	170·4	99·9	56·5	31·3	12·0	4·1	2·1	1·0	6
	303·4	268·1	164·9	98·9	57·0	30·7	13·6	4·2	2·2	1·0	7
	306·1	271·3	166·9	95·9	57·1	30·5	11·1	4·4	2·1	0·9	8
	306·4	269·8	164·6	95·1	54·2	30·1	11·6	4·3	2·3	0·9	9
	305·3	271·8	159·8	95·7	52·0	29·5	10·6	4·3	2·4	1·0	10
Averages	304·4	269·9	166·1	97·9	55·8	31·1	12·1	4·50	2·27	0·96	
Standard deviations	2·58	1·37	2·93	1·95	1·89	1·03	0·94	0·27	0·15	0·05	
Coefficient of variation	0·85 per cent.	0·51 per cent.	1·76 per cent.	1·99 per cent.	3·38 per cent.	3·30 per cent.	7·81 per cent.	5·96 per cent.	6·55 per cent.	5·10 per cent.	

WHAT THE OTHER HALF MAKES

ENGINEERING PRODUCTS FROM THE SOVIET BLOC

In any consideration of world markets, the countries of the Soviet Bloc represent a relatively unknown and untried factor. But increasingly they are being recognised as potentially fruitful fields for trading, and some of their advantages were noted in a previous article published in ENGINEERING on March 15 (page 322). If, however, these markets are to be tackled to best effect, it is necessary to know not only their needs, but also the extent to which these can be met by local production capacity. It is also desirable, since trade is necessarily reciprocal, to know what goods they have to offer. Some typical products of the Communist countries are described in the present article, and in particular engineering equipment made in the Soviet Union, Czechoslovakia and East Germany, since these are probably the most industrialised members of the group. The first part published below deals with Soviet and Czechoslovak products. It should be emphasised that the equipment described is not necessarily novel, but is covered rather to provide examples of current manufacturing practice. A further article in this series based on the Leipzig Fair will examine the probable import requirements of these countries.

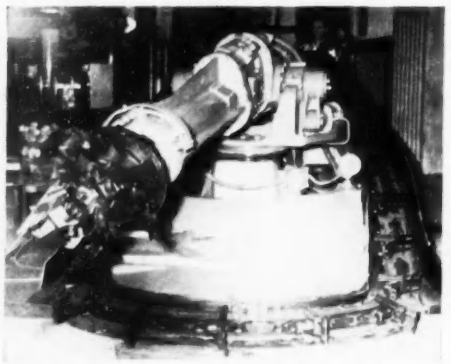


Fig. 1 Coal-cutting combine PK-3 made in the Soviet Union. It is designed for cutting single-track trapezoidal drifts through coal, and at mixed faces with separate excavation of coal and rock.

1—Soviet Union

The largest single pavilion at the Leipzig Fair is that occupied by the Soviet Union, which this year displayed a very considerable range of engineering and consumer products, ranging from excavators and motor cars to food and drink. For the purpose of this article, three typical groups of exhibits will be discussed—heavy machinery, electrical plant, and instruments. Further information may be obtained from Vsesoyuznoye Obyedineniye Machinoexport, Moscow, U.S.S.R., or from ENGINEERING.

Heavy and Agricultural Machinery

Coal-Cutter Combine.—Mining machinery was well represented, and included the PK-3 coal-cutter combine illustrated in Fig. 1. It is designed for cutting single-track trapezoidal drifts through coal and at mixed faces, with separate excavation of coal and rock. The cutting unit comprises a tapered cutting head with replaceable teeth mounted on the tapered surface along a spiral line; the head is fitted to the end of the boom shaft of the cutting unit. Movement of the rotating head at the coal face in any direction is effected by means of horizontal and vertical hydraulic cylinders. The blasted rock is removed by a ring-type scraper conveyor with cantilever scrapers, and the entire combine travels on crawler tracks.

Coal Cutter Combine PK-3

Capacity in coal cut per shift, lin. m.	20
Capacity of mixed face per shift, lin. m.	14
Average specific pressure at face, kg. per sq. cm.	0·5
Drift section:	
Width at floor, m.	2·8 to 3·48
Height, m.	2·0 to 2·8
Area of section, sq. m.	5·0 to 8·5
Total electric motor power, kW	43·6
Weight (without loader), tons	10·7

Drilling Unit.—The model "Uralmash 3D" drilling rig, which is shown in Fig. 2, is designed for forced turbine and rotary drilling of oil and gas wells up to 5,000 metres deep in various geological conditions. It is said to be dependable, efficient, easy to control and simple to erect, and comprises the units described below.

The crown block (type U3-200-2), or stationary part of the tackle block system, embodies two sections of three sheaves mounted on a common sheave pin. Its design permits each of the sheaves or sheave sections to be turned through 180 deg. in case of assymetrical wear of the sheave grooves. Owing to the large sheave diameter (1,000 mm.) and fine finish of the grooves, the cable works in favourable conditions with a minimum of wear and low power losses. The block, which is intended for use with a 33 mm. diameter cable, weighs 3,930 kg. and has a load capacity of 200 tons, is 2·3 metres long, 1·45 metres wide and 1·324 metres high. It is used for raising and lowering operations, drilling tool feed to the well bottom and for auxiliary work. The travelling block (type U4-200-2) is the moving part of the tackle block system. The sheaves, of which there are five, are mounted on a common sheave pin between two side plates, and the load capacity is 200 tons. The hook (type U5-200-1), which is of triplex pattern, and has a load capacity of 200 tons, incorporates a spring inside the hook body which permits quick lifting of drill pipes after the tool joints have been unscrewed. The spring, which gives a travel of 145 mm., takes a load of 3,700 kg. at the travel start and 10,000 kg. at travel limit. The swivel (type U6-ShV14-160M), which is the connecting part between drill pipe string and hook, is designed to supply drilling fluid into the rotating drill pipe string and to ensure its free rotation. Weighing 1,900 kg., with a load capacity of 160 tons, it is capable of a maximum speed of 350 r.p.m. The stem passage has a hole diameter of 100 mm.

The rotary unit, which serves to rotate the drilling tool and to support the drill pipe string while making and breaking joints, is designed for high-speed operation with a maximum table speed of 300 r.p.m. Its enclosed design and the labyrinth seals in the top and bottom portions of the table protect the oil bath from penetration of drilling mud. The rotary table, which is 520 mm. in diameter, takes a load of 130 tons, with a maximum transmitted power of 350 h.p. The draw unit (type U2-5-4), which is used for raising and lowering the drilling tool and casing pipes, for transmitting rotation to the rotary unit, for screwing and unscrewing drill pipe joints, and for auxiliary load hauling operations, is equipped with an automatic cathead for breaking drill pipe joints, a friction cathead with planetary gear for auxiliary operations and also a plain cathead. Hoisting speeds are changed by means of a transmission unit, from which power is transmitted to the draw unit by two propeller shafts. Use of two shafts allows quick raising

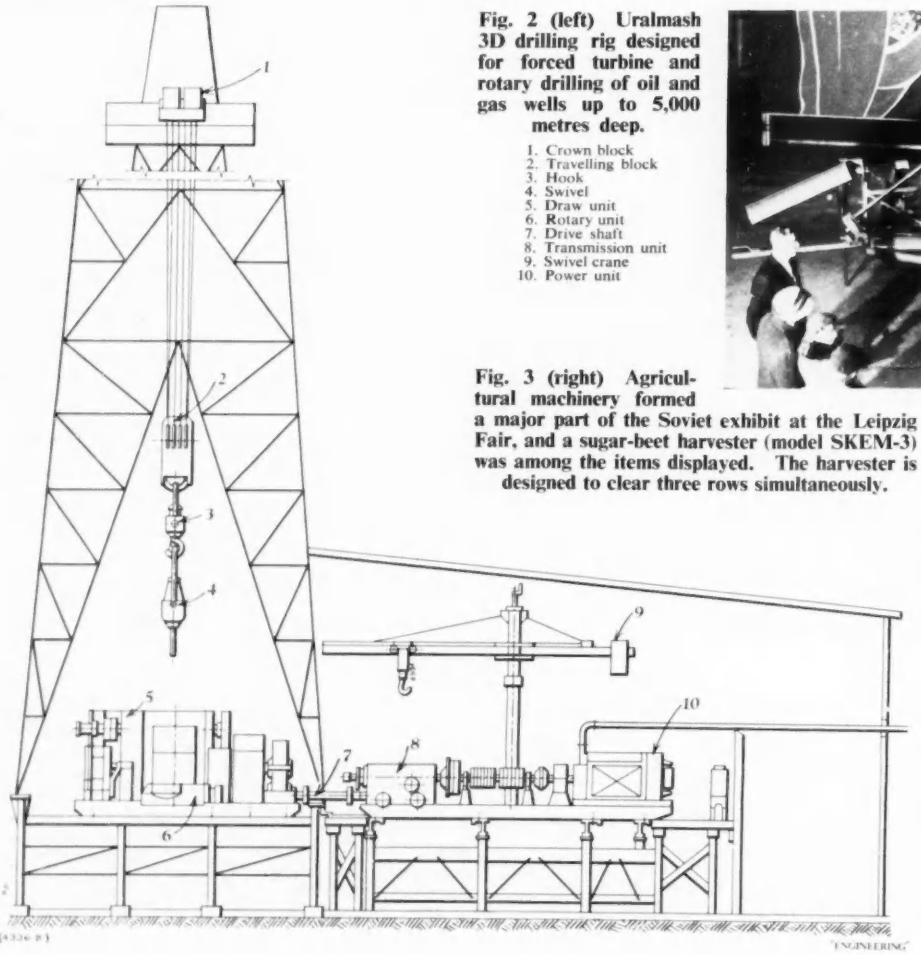


Fig. 2 (left) Uralmash 3D drilling rig designed for forced turbine and rotary drilling of oil and gas wells up to 5,000 metres deep.

1. Crown block
2. Travelling block
3. Hook
4. Swivel
5. Draw unit
6. Rotary unit
7. Drive shaft
8. Transmission unit
9. Swivel crane
10. Power unit

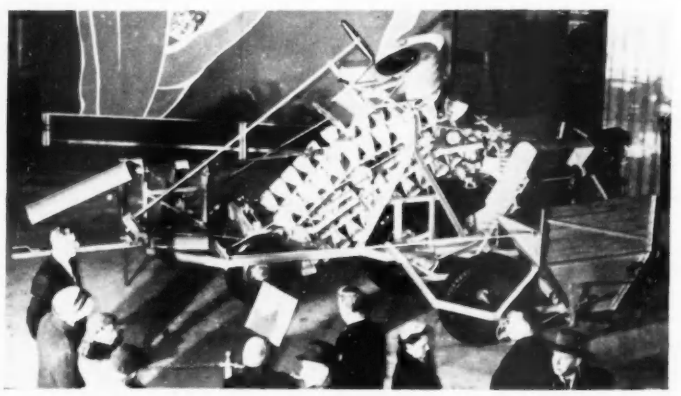


Fig. 3 (right) Agricultural machinery formed a major part of the Soviet exhibit at the Leipzig Fair, and a sugar-beet harvester (model SKEM-3) was among the items displayed. The harvester is designed to clear three rows simultaneously.

of an empty elevator, independently of the transmission.

Details of Draw Unit

Permissible pull on cable end running on to drum	22 tons
Drum diameter	800 mm.
Number of hoisting speeds	5
Number of rotary transmission speeds	4
Hook lifting speed (using five sheaves on crown block and four sheaves on travelling block)	0·24 to 1·90 metres per second
Overall dimensions:	
Length	6,150 mm.
Width	2,000 mm.
Height	2,760 mm.
Weight	26,300 kg.

A double-acting duplex slush pump (type U8-3) is employed, designed for delivering mud-laden drilling fluid into the well through the drill pipe string and for carrying crushed rock out of the well during turbine or rotary drilling of deep and super-deep wells. In turbine drilling the mud delivered under pressure by the pump for rotating the turbine is also used.

Details of Slush Pumps

Number of pistons	2
Piston stroke	450 mm.
Number of piston cycle strokes per min.	55
Inner diameter of nozzles:	
Discharge	110 mm.
Suction	250 mm.
Sheave diameter	1,600 mm.
Maximum sheave speed	310 r.p.m.
Power required	470 h.p.
Overall dimensions:	
Height	4,850 mm.
Width (including sheave)	3,150 mm.
Length	3,400 mm.
Weight	19,900 kg.

Pump Output and Pressure (for Turbine Drilling)

Cylinder liner size, mm.	Output, litres per sec.	Discharge pressure, kg. per sq. cm.
200	45	55
185	37	70
170	31	85
150	24	110
130	17	150

The power plant comprises five Diesel engines (type V2-400A) each rated at 400 h.p. and giving together a total of 2,000 h.p.: a group of three compounded by V-belts driving the draw and rotary units and one of the slush pumps, and a group of two driving the other slush pump. The draw and rotary units take 1,200 h.p., while each slush pump requires 470 h.p.

Drives for Pig Machine.—A system of electrical drives has been developed in the Soviet Union for control of all the equipment of a blast-furnace pig machine, such as: (*a*) two single-belt conveyors designed to transport moulds filled with molten pig iron, which is cooled in the process to a degree necessary for hardening; (*b*) two mechanisms to operate sprayers used for coating the inner surface of moulds with a lime solution; and (*c*) a 100 ton ladle tipping winch on the stand of the pig machine, which tips a ladle containing molten pig iron.

The system provides for the even flow of pig iron and the equal filling of belt moulds with molten pig iron in the pig machine. The system ensures the proper coating of the inner surfaces of moulds with a lime solution, thus protecting the moulds from corrosion due to molten pig iron and also from the adherence of pigs. The speed of the electric drive of the conveyor belts can be reduced, and is regulated in accordance with the temperature of the poured pig iron and the length of the route over which the pig iron is transported in the moulds on the belt of the pig machine. Direct current is used for the electrical drive of the ladle turning winch. This provides for wide, stable speed regulation while the ladle is tipped and for high speeds while it is returned to its original position.

Beet Harvester.—An important section of the Soviet display was devoted to agricultural machinery, and Fig. 3 shows the SKEM-3 sugar-beet harvester which formed part of the exhibit. The machine, which clears three rows simultaneously over a width of 44·5 cm., first loosens the beets in the ground, beheads them, cleans off any adhering earth, gathers them in a hopper together with the tops, and finally piles them in separate heaps, on the cleared area behind the machine.

Electrical Equipment

Circuit Breaker.—An example of Soviet power distribution equipment is the VV-3002 132/600T air circuit breaker, which is designed to close or

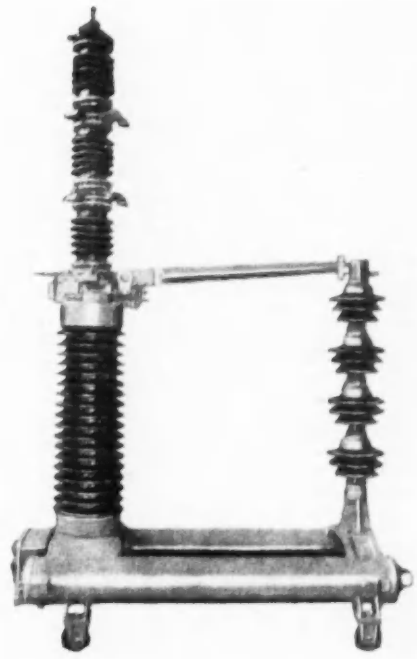


Fig. 4 Soviet air circuit breaker VV-3002 rated at 132 kV and 600 amperes. The greatest time for disconnection is 0·05 sec. and the maximum arcing time 0·015 sec.

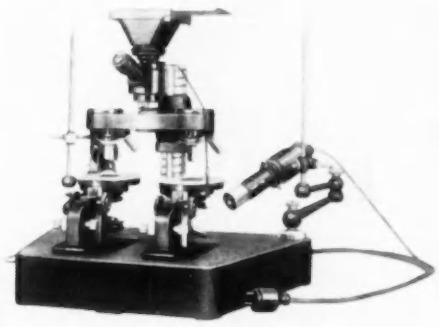


Fig. 5 Comparison microscope MEeS-10 for the investigation of material evidence in legal inquests. It may also be used in engineering, biology or medicine where it is necessary to superimpose one image on another for comparison.

open an electrical high-voltage circuit under normal or abnormal conditions, with automatic operation in case of fault. It is suitable for use in outdoor tropical conditions. The breaker comprises three mechanically disconnected similar single-pole units having separate control (both remote and manual), and embodies a built-in quick-acting automatic reclosing device. Each single-pole unit has a special ventilation unit for blowing dry air over all internal parts.

The breaker is stated to have the following advantages: (1) quick and dependable disconnection during short circuit; (2) short time of disconnection—0·05 sec.; (3) short time of arcing—0·015 sec.; (4) no necessity to test the contacts after disconnecting short-circuit current; (5) absence of oil; and (6) fire safety.

The arrangement of the circuit breaker is shown in Fig. 4. The movable contact is normally pressed by a spring of 100 to 120 kg. force to the fixed contact. During circuit opening, compressed air runs through the air manifold inside the insulator and lifts the movable contact. An arc appears at the point of contact breaking, and is quenched by a flow of compressed air. By zero current the arc is dowsed, and the arcing products are then expelled by air flow. At this moment the pneumatic drive of the disconnector is set in motion and lifts a disconnector knife, which eliminates the voltage from the chamber. After this the compressed-air supply for the blowing-out chamber is stopped and the spring returns the movable contact into its primary position. The circuit closing is accomplished pneumatically by the disconnector knife.

Data for Air Circuit Breaker

Rated voltage, kV	132
Rated current, amperes	600
Dry-discharge voltage of supporting column, kV effective	517
Wet-discharge voltage of supporting column, kV effective	337
Maximum disconnected current at rated voltage, amperes	11,500
Maximum three-phase power of disconnection at rated voltage taking into account automatic reclosing, MVA	3,000
Maximum through current:	
Amplitude value, amperes	35,000
Effective value, amperes	20,000
Current of thermal stability:	
Single-second, amperes	31,000
Decasecond, amperes	10,000
Maximum time of disconnection, sec.	0·05
Time of arcing, sec.	0·015
Full time of disconnection, sec.	0·065
Time of connection, sec.	0·3
Rated air pressure, atm. (gauge)	20
Minimum air pressure at operation, atm. (gauge)	16
Minimum air pressure at which automatic reclosing is possible, atm. (gauge)	19
Air consumption for one disconnection of one single-pole unit given to atmospheric pressure, cub. m.	3·6
Air consumption for disconnection of one single-pole unit, cub. m.	0·1
Air consumption for scavenging of one single-pole unit, cub. m. per hour	0·32
Air consumption for leakage of one single-pole unit, cub. m. per hour	0·05
Reservoir capacity of single-pole unit:	
Without additional reservoirs, cub. m.	0·37
With additional reservoirs, cub. m.	0·74

Frequency Changer.—The Ee-75A frequency changer is used to step up the frequency and step down the voltage, and to supply electric energy to various electric tools with step-up frequency motors. The set consists of an electric motor and generator, the rotors of which are mounted on a common shaft, while the stators are arranged in a common frame. Fan blades are provided on the motor rotor for cooling the set.

Frequency Changer

System	Three-phase A.C.
Voltage:	
Primary	380/220 V
Secondary	36 ± 10 per cent.
Frequency (synchronous), c.p.s.:	
Primary	50
Secondary	200
Speed, r.p.m.:	
Synchronous	3,000
On load	2,800
Input, kW	4·85
Power factor:	
Set	0·72
Motor	0·88
Output, kVA	3·5
Duty	Continuous
Overall dimensions, mm.:	
Length	640
Width	316
Height	340
Weight, kg.	66·0

High-Frequency Heating.—Designed for induction heating of metal components and chiefly for surface hardening, the LG3 high-frequency units comprise two main items: a transformer cabinet and an oscillator cabinet. The oscillator employs a water-cooled valve (two in the LG3-60 model) and supplies the oscillatory circuit system to provide smooth regulation of the heating. The plate voltage of the oscillator valve can be continuously regulated from 9,000 to 13,500 volts, and the heater voltages of the oscillator valve and the gas-filled plate-rectifier triodes are stabilised. The operation is controlled by handles and push buttons with the aid of indicating instruments all located on the front panel.

High-Frequency Units

Type of installation	LG3-30	LG3-60	LG3-100
Maximum oscillatory output, kW	30	60	100
Operating frequency, c.p.s.	2 to 3×10^4	2 to $2{\cdot}5 \times 10^4$	
Maximum power consumption:			
(*a*) Three-phase, kVA	50	100	160
(*b*) Single-phase, kVA	5	10	12
Three-phase supply voltage (50 c.p.s.)	220 or 380 (stated when ordering)		
Cooling-water intake litre per hr.	750	1,500	2,500
Floor space, mm.	2,800 × 1,400	2,800 × 1,400	2,900 × 1,700
Height, mm.	2,300	2,300	2,300
Total weight, kg.	2,400	3,000	3,200

Instruments

Comparison Microscope.—The MEeS-10 comparison microscope illustrated in Fig. 5 was designed for accurate investigation of material evidence in legal inquests. The instrument permits visual examination of both translucent and opaque objects such as bullets, cartridges, documents, structures of cloth, paper and fibres, and can be used in engineering, biology or medicine when the investigation is based upon the principle of comparison with a standard. The microscope, which is suitable for bright and dark-field work, consists of a duplex objective tube and a common eyepiece. Light is passed through the two objectives, and the two beams of light illuminating the two objects to be compared are combined into one field of vision in the common eyepiece by means of prisms, the eyepiece being set on the line of separation. The microscope has two identical stages, each with coarse and fine adjustment. The upper part of the stage is circular and capable of revolving, and is graduated in degrees. The illumination system consists of two lamps hinged so as to permit illumination of opaque objects from any side, and also illumination of transparent objects by means of mirrors arranged under the stage. A special bullet holder for holding both deformed and undamaged bullets is provided. The angle of rotation of the bullet is read on a graduated scale. Cartridges may be held in a special cartridge holder. Both attachments are mounted on a mechanical stage having movements in two directions at right angles to each other. A fixed-length camera is fitted to the upper part of the microscope stand.

Sample Picking Unit.—The automatic sample picking device AP-1 is designed to select samples automatically from a continuous flow of pulp or fine friable materials. It comprises the following main items: a sample picking knife, a mechanism governing the movement of the knife and an automatic starter with time relay. The unit is illustrated in section in Fig. 6, to which reference is made in the following description.

Reciprocating motion is imparted to the sample picking knife (1) by a worm gear mechanism connected to the electric motor (12) through a flexible coupling (11). The worm gear mechanism comprises a carriage (3) bearing a flat thread nut (4) engaged with a lead screw (5), and moving in both directions on rollers (6) along guides (7) mounted within a tube (2). This tube is provided with a longitudinal slit on the ends of which are fastened rubber end stops (8). The carriage incorporates a pressure bar (10), which operates the end switch (9) by means of a roller.

The function of the automatic starter is to switch on the sample picking device automatically after a predetermined time. The unit is housed in a case and comprises a time relay, two reversing electromagnetic starters, a three-phase switch, a two-phase switch and a signal lamp. The time relay is a synchronous motor running at 2 r.p.m. with a 220 volt alternating-current coil, and a worm reduction gear (120 : 1). A timing disc is attached to worm shaft. Separate brackets carry a pendulum and a contact unit with open contacts. The sample picking knife is made in three forms: (1) for horizontal pulp flow, (2) for vertical pulp flow, and (3) for fine friable materials. The knife is given a uniform straight-line motion to meet the flow of material, and thereupon takes a sample.

The timing disc, which is a toothed wheel, revolves at a speed of one revolution per hour and the teeth engage with a pawl so lifting the pendulum. As the pawl is released, the pendulum briefly closes the contacts of the contact unit and energises the coil of one of the starters. The starter then switches on the electric motor of the knife movement mechanism, which rotates the lead screw and actuates the carriage and hence the sampling arm. When the carriage reaches the end of its travel the roller is depressed and the motor stopped. The second starter is similarly operated by another tooth on the timing disc so restarting the motor in reverse and returning the carriage to its initial position. The number of samples taken per hour ranges from 1 to 12.

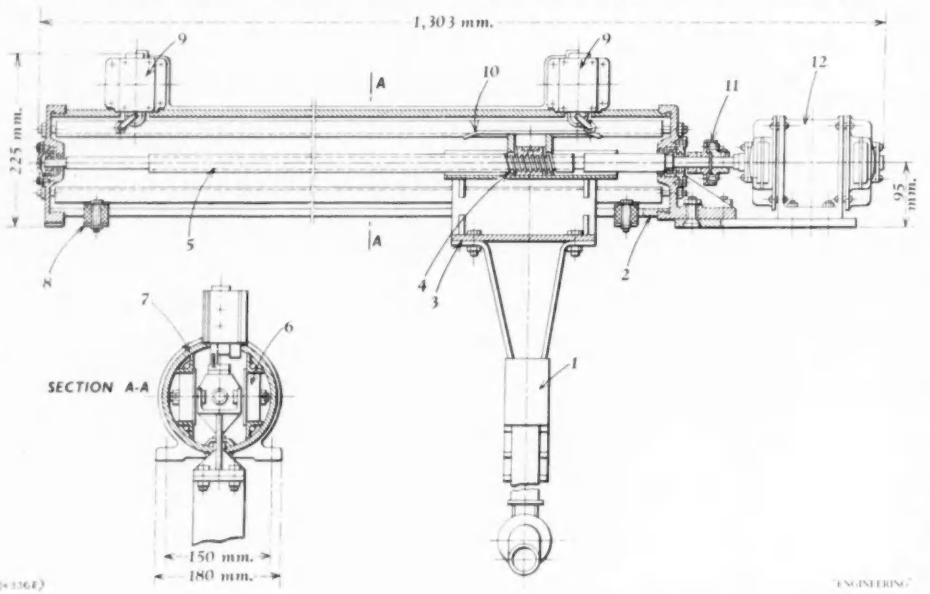


Fig. 6 (above) Sample picking mechanism (AP-1) for automatic sampling from continuous flows of pulp or fine friable materials.

1. Sample picking arm
2. Rigid tube
3. Carriage
4. Flat thread nut
5. Lead screw
6. Rollers
7. Guides
8. Rubber end stops
9. End switch
10. Pressure bar
11. Flexible coupling
12. Electric motor

Fig. 7 Designed as a research tool for structural analysis, the Soviet URS-55 table X-ray set is sufficiently small and light as to be portable.

Table X-Ray Set.—Designed for structural analysis, the type URS-55 table Roentgen set is intended for service in scientific research laboratories and in the laboratories of industrial plants. It is illustrated in Fig. 7. The small dimensions, relatively light weight and simplicity of assembling of the unit make it suitable for use as a portable set. The set is designed for operation with a type BSVL Roentgen tube and with various types of structural analysis chambers. The unit allows simultaneous examination of two to four samples, according to the number of available tube windows. The design assures full electrical safety and provides ample radiation protection, as the rays can emerge only through windows in the protective casing of the tube. Each window of the protective casing can be closed by means of a special shutter.

The half-wave self-rectifying scheme has been adapted for tube voltage supply. The unit can provide a voltage with a crest value up to 55 kV, at a tube current up to 30 mA. The maximum permissible voltage and values of the current depend on the material of the Roentgen tube anode mirror (target). The unit is designed for single-phase, 50 cycle, alternating-current supply at 127 or 220 volts. The power input to the unit does not exceed 3 kW. It is necessary to earth the unit during operation and to connect it to a water supply system or to a water tank that provides a water flow of about 2 to 3 litres per min., at a pressure of not less than 0·35 atm. The total weight of the set is approximately 120 kg.

Designation of Items

For convenience the Russian characters used to designate the various items described have been transliterated into English equivalents. The corresponding Russian designations may be obtained from the following table.

English	PK—3	3D	U3	ShV14	V2—400A
Russian	ПК—3	3Д	У3	ШВ14	В2—400А
English	Ee—75A	LG 3	MEeS	AP—1	URS—55
Russian	Е—75А	ЛГ 3	МИС	АП—1	УРС—55
English	SKEM—3	VV—3002	132/600T		
Russian	СКЕМ—3	ВВ—3002	132 600Т		

2—Czechoslovakia

Among the most impressive engineering displays at the Leipzig Fair was that housed in the Czechoslovak pavilion. Of particular note were the sections devoted to machine tools, turbines and power plants, and road vehicles. A selection of exhibits are discussed below under these headings. In addition, a wide range of optical and precision equipment was shown. Further details concerning machine tools may be obtained from the foreign trade corporation, Strojexport, and for heavy plant from Technoexport, both of Prague, Czechoslovakia.

Machine Tools

Boring Mill.—The largest machine tool displayed was a horizontal boring and milling machine made at the Skoda works. Known as the model WD 160 and illustrated in Fig. 8, it has a spindle diameter of 160 mm. and steplessly variable feeds and speeds, regulated by means

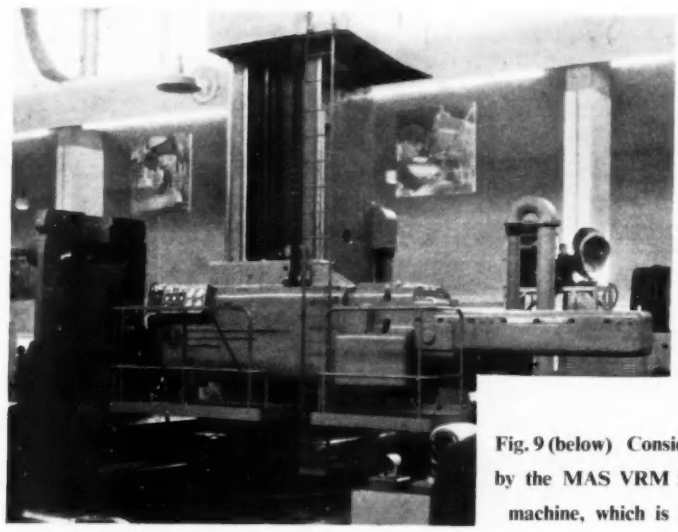


Fig. 8 (left) The spindle of the Skoda WD 160 horizontal boring and milling machine is carried in a rectangular sleeve which slides in a recess in the main carriage. Rigidity is thus retained at full outward travel of the cutting tool.

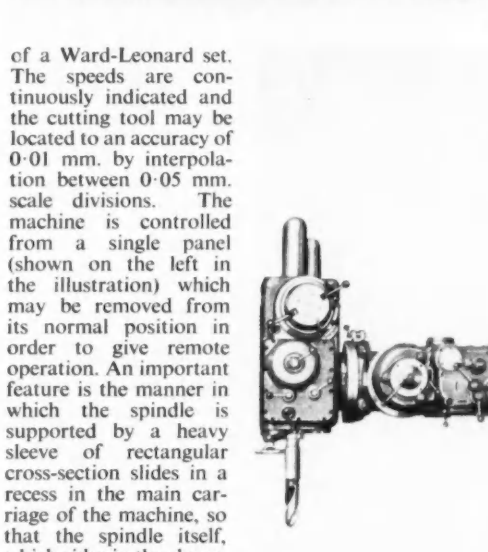


Fig. 9 (below) Considerable flexibility is afforded by the MAS VRM 50 universal radial drilling machine, which is made in Czechoslovakia.

of a Ward-Leonard set. The speeds are continuously indicated and the cutting tool may be located to an accuracy of 0·01 mm. by interpolation between 0·05 mm. scale divisions. The machine is controlled from a single panel (shown on the left in the illustration) which may be removed from its normal position in order to give remote operation. An important feature is the manner in which the spindle is supported by a heavy sleeve of rectangular cross-section slides in a recess in the main carriage of the machine, so that the spindle itself, which rides in the sleeve, is reinforced against transverse stresses. The maximum travel of the sleeve is 1,250 mm. Thus even when the cutting tool is at the full extent of its outward travel, with considerable overhang, adequate rigidity is retained. The machine may consequently be used not only for boring, but also for milling, grinding and planing operations. Also exhibited were a universal milling machine, the FRU63, and a vertical milling machine known as the SRV 80.

Radial Drill.—An illustration on page 323 of our issue of March 15 showed the MAS VRM 50 universal radial drilling machine. In addition to the universal freedom of the head with respect to the cantilever arm, the arm itself can swing about a horizontal axis and slide under power on the vertical pillar; further freedom is provided by horizontal motion of the pillar carriage along the bed. The cantilever arm comprises two booms, one on each side of the pillar. A view of the complete machine appears in Fig. 9 and of the spindle head in Fig. 10. Some details of the machine are given below.

Universal Radial Drill VRM5O

Max. diameter of cut in steel	50 mm. (1·97 in.)
Spindle diameter	65 mm. (2·56 in.)
Distance of spindle axis from axis of pillar:	
Maximum	2,227 mm. (87·68 in.)
Minimum	1,127 mm. (44·37 in.)
Distance of arm from floor when horizontal:	
Maximum	2,734 mm. (107·63 in.)
Minimum	400 mm. (15·75 in.)
Drilling depth	350 mm. (13·78 in.)
Diameter of pillar	400 mm. (15·75 in.)
Rotation of spindlestock about horizontal axis	360 deg.
Rotation of spindlestock:	
Above horizontal axis	90 deg.
Below horizontal axis	90 deg.
Spindle speeds:	
Number	18
Range	16 to 803 r.p.m.
Spindlestock motor:	
Speed	1,420 r.p.m.
Power	4 kW
Dimensions:	
Floor space	3,600 × 2,620 mm.
Height	3,335 mm. (131·30 in.)
Weight	7,250 kg.

Slotter.—Fig. 11 shows the TOS HOT 100 slotting machine, designed for a wide variety of operations in heavy machine building. The cutting stroke takes place during upward motion of a ram, which is driven through electromagnetic clutches. There are three cutting speeds: 5·6, 8 and 11·2 metres per minute (18·4, 26·2 and 36·7 ft. per min.), with a return speed of 16 metres per minute (52·5 ft. per min.). The machine weighs 3,150 kg.

Lathes.—Among Czechoslovak lathes the model SR 2000 stands out by virtue of its size (weight 43 tons). Another recent design is the semi-automatic lathe SPE 50 (MAS), which is intended for turning, medium-size machine parts in multiple and quantity production; turning can be carried out simultaneously on the outer or inner surfaces or faces of a workpiece held in the chuck by means of two carriages on separate beds. The TOS SP 31 semi-automatic copying lathe incorporates electro-hydraulic work-cycle control and is intended primarily for the machining of shafts. It is claimed that complicated shapes can be cut at high speed to an accuracy of 0·02 to 0·03 mm. (0·0008 in. to 0·0012 in.) by copying from a pattern or metal template, and recessing cuts can be taken at the same time. The automatic work cycles of the copying and recessing carriages are set by a control drum and contact pins in accordance with punched cards. This arrangement permits automatic changing of spindle speeds and feeds during operation of the machine at full load.

Grinder.—Another machine with automatic cycle is the TOS BUA31 hydraulic universal cylindrical grinding machine. It is designed for mass and single item production, using either hydraulic table traverse or plunge cutting, and for internal, external or face grinding. The semi-automatic cycle is controlled by a single hand lever. Other details are given below.

Universal Cylindrical Grinder BUA 31

Swing over bed	315 mm. (12½ in.)
Distance between centres	1,000 mm. (39½ in.)
Grinding wheel	500 × 80 × 203 mm. (19⅝ × 3⅛ × 8 in.)
Diameter of chuck	200 mm. (8 in.)
Workhead swivels	90 deg.
Wheelhead swivels	± 60 deg.
Workspindle speeds	15-24-38-60-95-150-235-375 r.p.m.
Table motion max.-min.	1,250-1 mm. (49½ in.-0·04 in.)
Cross travel of wheelhead	170 mm. (6·7 in.)
Table speed (steplessly variable)	0·05-6 m. per min. (2-236 in. per min.)
Electric motors, power	11,325 kW
Weight of machine	4,800 kg. (10,600 lb.)

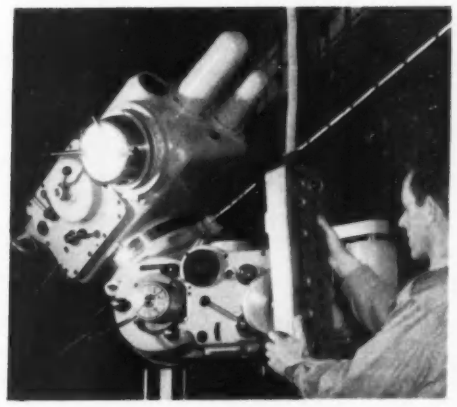


Fig. 10 Spindle head of the VRM 50 radial drilling machine, showing universal joint and flexibly suspended control panel.

Fig. 11 The HOT 100 slotting machine is designed so that the cutting stroke occurs during the upward motion of ram, which is driven through alternately coupled electromagnetic clutches.

Special Machines.—Novel machines exhibited included an automatic hammer mill (KR16), a supersonic drill for cutting metal and other materials, and an electro-erosive metal-working machine.

Turbines and Power Plant

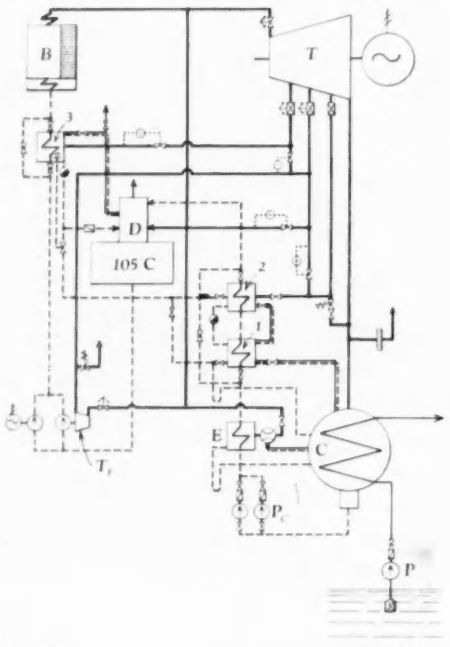
Condensing Steam Turbines.—Among condensing turbines made in Czechoslovakia are a series ranging in output from 2·5 to 6 MW built at the Skoda works. These machines are of impulse pattern with a Curtis wheel acting as a regulating stage and a set of one-row impulse wheels. Features of these plants include labyrinth glands, steam-jet air ejectors, starting ejectors, surface condensers, three-stage condensate re-heating using low-pressure and high-pressure surface heaters, and various safety devices.

The governing gear is of interesting design. The steam supply to the separate nozzle groups of the regulating stage is regulated by nozzle control valves of special design. It is claimed that the use of these valves makes it possible for steam to be transmitted more rapidly and with a smaller steam-pressure loss than is the case with many valves working with lower steam velocity. Consequently, smaller valves and valve chambers can be used. The lifting of the valve cones in succession is effected from the main servo-motor, the oil supply for which is controlled by a slide valve operated by a speed governor or synchroniser. For switching the turbo-sets in parallel it is possible to change the middle speed during operation either by hand or by means of a small electric motor operated from the control room. An emergency governor is fitted to the turbine shaft, which is set to operate at 10 to 12 per cent. above the rated speed, closing the stop valve and shutting off the steam supply to the turbine. At the same time the nozzle regulating valves are likewise closed. There are three models of 2·5, 4 and 6 MW nominal output, all running at 3,000 r.p.m. Details of the condensate re-heating system are given in Fig. 12. Another condensing steam turbine exhibited was a single-cylinder machine made by Erste Brünner Maschinenfabrik; this machine has an output of about 4 MW and weighs 16 tons.

Packaged Power Plant.—Fig. 13 shows a 1,500 kW packaged power plant employing a condensing steam turbine, and designed for the generation of electric power on remote or isolated sites. It is planned to impose minimum demands on assembly, maintenance and operation. The station is erected on a previously prepared concrete floor from easily transportable blocks carried on frames, the dimensions of which do not exceed the international railway loading gauge, and no block weighs more than 15,000 kg. (15 tons). Erection of the plant is said to require 3 to 4 weeks. There is also a companion unit of 750 kW.

The packaged power plant of 750 kW comprises one 6 tons per hour boiler set, while the 1,500 kW unit employs two boiler sets, each with a rated steam pressure of 24 atmospheres (gauge), superheat temperature 380 deg. C. and feedwater temperature 105 deg. C. The boiler is of radiation double-body type, with double-stage evaporation, steam superheater, feedwater heater, and equipment for artificial draught and blowing of combustion air. The lower frames of the boilers are provided with a mechanised belt travelling stoker and a fuel chute. The design of the set is said to be suitable for a wide range of climatic conditions and permits the use of fuels of widely different calorific value—for lignite from 3,700 kilocalories and for pit coal from 4,500 kilocalories upwards. Ungraded lignite and non-coking pit coal of grain size up to 50 mm. may be used without artificial increase of the dust content. A small modification to the combustion chamber permits the burning of wood. The complete installation includes raw-water treatment plant, coal-handling plant, slag-removal equipment, condensing plant, cooling tower, all associated electrical equipment, and an erecting crane.

For the auxiliary drive of pumps, fans and lighting, especially when starting, the packaged power plant is equipped with an independent Diesel set. The set consists of a Diesel engine having an output of 90 h.p. at 1,500 r.p.m., with tropical radiator and alternator of an



(A356A) ENGINEERING

Fig. 12 (above) Condensate re-heating system for Skoda 2·5 to 6 MW condensing steam turbines.

(A—boiler; T—turbine; D—de-aerator; C—condenser; P—cooling pump; Pc—condensate pump; and TF—feedwater-pump turbine.) Condensate re-heating is in three stages: in low-pressure heater (2) with steam from the uncontrolled extraction point of lowest pressure, in de-aerator (D) with reduced steam from the second uncontrolled extraction point, and finally in high-pressure heater (3) with reduced steam from the uncontrolled extraction point of highest pressure. The heating steam condensate of low-pressure heater (2) is passed into drain cooler (1) where it cools down and after emitting its heat to the condensate it flows through a syphon into condenser (C). The heating steam condensate of high-pressure heater (3) is passed into feedwater de-aerator (D), and if the load of the turbine falls, it is automatically by-passed by means of a level regulator into low-pressure heater (2). Low-pressure heater (2) is vented to drain cooler (1), which in turn is vented to condenser (C). The pressure in the steam space of the drain cooler can be controlled by a de-aerating valve arranged on drain cooler (1), so taking care of any continuous outlet of condensate even at a reduced turbine load. High-pressure heater (3) is vented to de-aerator (D), and, if the load of the turbine falls, to atmosphere. Feedwater de-aerator (D) is heated up to 105 deg. C. by reduced steam from the second uncontrolled extraction point, and at a lower load of the turbine by reduced steam from the extraction point of the highest pressure. Drain cooler (1) and low-pressure heater (2) have a common by-pass for the heated condensate, while high-pressure heater (3) has a separate by-pass for feedwater. The high-pressure heater is not provided if condensate is to be heated to 105 deg. C. only, which depends on the boiler design. If small turbine (T_F) driving the feedwater pump is in service, its exhaust steam is passed into the pipeline of the second uncontrolled extraction point, and in the case of an excess, the exhaust steam is automatically by-passed into the extraction point of lower pressure, and later through a hand-operated slide valve and a safety valve into the condenser.

Fig. 13 (right) Packaged power plant of 1,500 kW rated output designed for use at remote or isolated sites. Power is provided by a steam turbine.

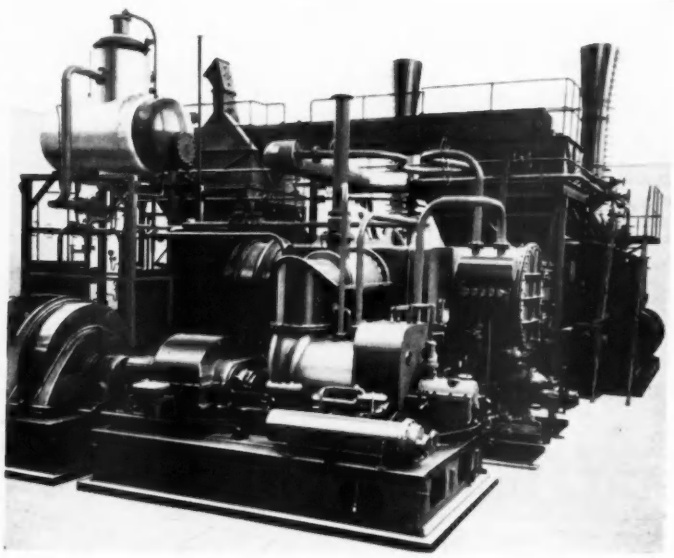
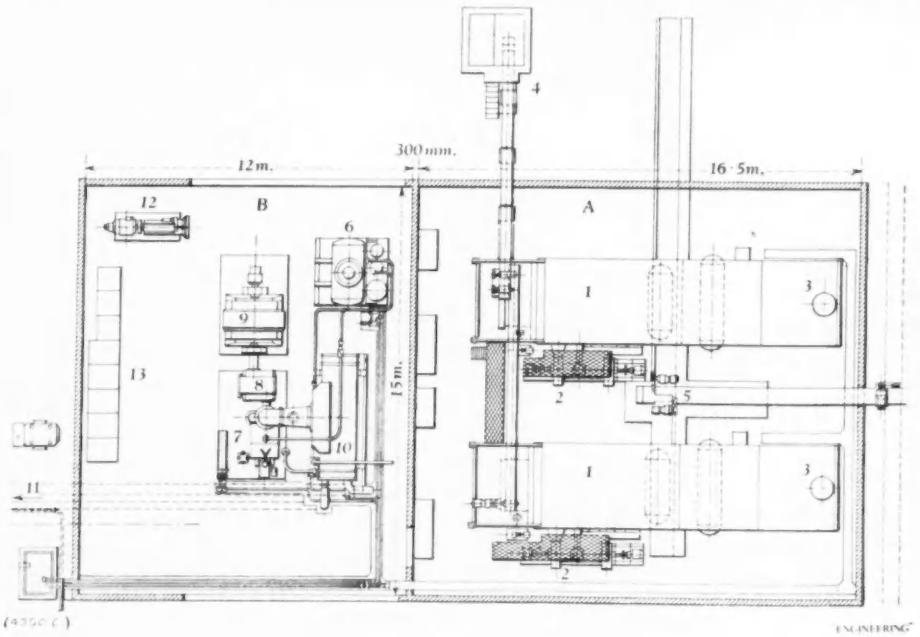


Fig. 14 (below) Layout of 1,500 kW packaged power plant.

A—*Boilerhouse:*
1. Two boilers, 6 tons per hour, 24 atmospheres gauge, 380 deg. C.
2. Two forced-draught fans
3. Two induced-draught fans and chimneys
4. Coal-handling equipment
5. Slag-removing equipment

B—*Engine House:*
6. Water treatment plant, 4 tons per hour
7. Steam turbine, 6,000 r.p.m.
8. Gearbox
9. Turbo-alternator, 1,500 kW, 1,500 r.p.m.
10. Condensing plant
11. For condensing tower
12. Diesel-electric set
13. Switchboard



(A356C) ENGINEERING

output of 60 kVA, 400/231 volts, 50 c.p.s., power factor 0·8, with exciter and shunt regulator. The set is located on a common foundation frame. Parallel running of the Diesel set with the turbo-alternator is possible. The electrical part of the plant is designed so as to recquire the minimum erection work on site. The generator is connected with the switchboard by means of a cable carried in a shallow channel. The switchboard is of box type, completely assembled and tested as an independent unit in the works. The switchboard and all apparatus are of tropical design. The unit can work in parallel with the grid or with another packaged power plant. Details of the turbine are given in the table below.

Technical Data for Package Plant Steam Turbine

Permanent rated output	1,500 kW/750 kW
Turbine speed	6,000/1,500 r.p.m.
Normal pressure at starting valve	22 at. abs.
Maximum pressure at starting valve	25 at. abs.
Normal temperature at starting valve	375 deg. C.
Maximum temperature at starting valve	390 deg. C.
Normal inlet temperature of cooling water	30 deg. C.
Maximum inlet temperature of cooling water	35 deg. C.

Fig. 15 Runner for Kaplan turbine designed to develop 18,700 h.p. The vanes are reversible and may be adjusted during operation by means of a hydraulic mechanism located in the hub.

Fig. 16 The Skoda 440 has four cylinders and is capable of more than 70 m.p.h. Petrol consumption is rated at 43 miles per gallon and the engine develops 40 brake horse-power at 4,200 r.p.m.

Kaplan Turbine.—A prominent exhibit was the five-vane Kaplan turbine (type 5K53) runner shown in Fig. 15. The turbine is designed to develop 18,700 h.p., and the runner, which has a diameter of 3·62 metres, weighs 28 tons. The runner vanes are reversible and can be set during operation to accord with variations in head and flow by means of a hydraulic mechanism located in the runner hub.

Road Vehicles

Motor Cars.—Motor cars are among Czechoslovakia's traditional products and the Skoda works has an international reputation in this field. Fig. 16 shows the Skoda 440, which has four cylinders and a top speed of 115 kilometres (71 miles) per hour. The cylinder capacity is 1,100 c.c., the bore 68 mm. and the stroke 75 mm., and the engine develops 40 b.h.p. at 4,200 r.p.m. Petrol consumption is at a rate of 7 litres per 100 km. (40 miles per gallon) and there are four forward gears and one reverse gear. Other Skoda cars include the 1201, which is also available as an estate car with a payload of 500 kg. and as an ambulance with accommodation for two stretcher cases.

Motor Cycles and Scooters.—Jawa-CZ motor cycles in the range 50 to 500 c.c. were displayed and a number of motor scooters. Fig. 17 shows the scooter Cezeta 175 (type 501), which, fitted with a 175 c.c. Jawa-CZ engine, is capable of 88 km. (55 miles) per hour and has a petrol consumption of 2·6 litres per 100 km. (110 miles per gallon). The engine develops 8 b.h.p. at 4,750 r.p.m. Other scooters recently introduced are the Jawa and Stadion, driven by 50 c.c. two-stroke engines, and polyester laminate sidecars weighing only 9 kg. were also exhibited.

Motor Lorries.—Among the heavy motor vehicles shown were the Skoda 706 AKVM and the Skoda 706R, which are chiefly used in the building industry, and the Praga V35. The V3S is intended for transporting loads up to 3 tons together with a trailer of 3 tons overall weight over difficult terrain. For ordinary road surfaces the payload may be 5 tons and the total weight of the trailer 5·5 tons. Other lorries on view included a Skoda 806, a dump truck with a maximum capacity of 8 tons, and the tank transporters Tatra 141 and 111C.

The foreign trade corporation, Technoexport, Praha (Prague) 2, Václavskén 56, Czechoslovakia, is responsible for the export of complete industrial plants, while Motokov is concerned with motor vehicles, including the products of Jawa, Skoda, Tatra and Praga.

To be continued

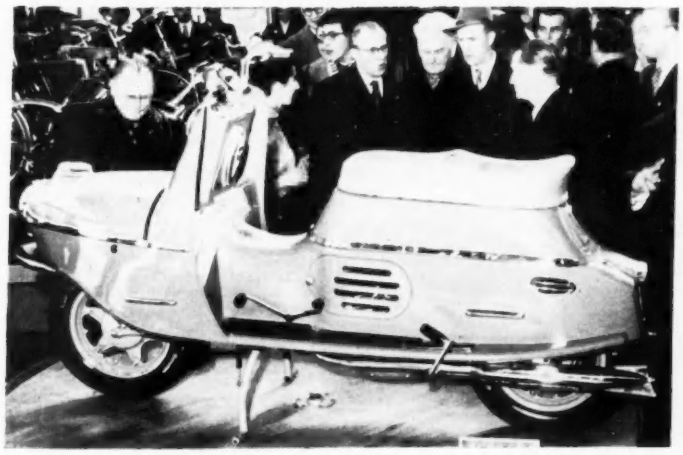


Fig. 17 (left) The 175 c.c. Cezeta motor scooter has a top speed of 55 m.p.h. and the petrol consumption is said to be 110 miles to the gallon. The engine develops 8 brake horse-power at 4,750 r.p.m.

INSULATION TESTER LOCATES EACH FAULT

British Exhibit at Utrecht

A British exhibit at the Utrecht Trade Fair was an instrument that tested the effectiveness of insulation. Based on 20 years research by the Electrical Research Association, it is the only commercial version of what has hitherto been a piece of specialised laboratory apparatus. The device—called the AC discharge detector—is manufactured by Hivolt Limited, Holland Park, London, and is valuable for testing transformers, cables, sockets, etc. Negotiations are in progress for its manufacture under licence in the United States.

Where two or more high voltage conductors are separated by an insulator there is the possibility that a spark will pass between the two conductors. If the insulator is a homogeneous medium such as air, the breakdown will occur at a particular spacing of conductor and at a particular voltage. Such predictability is invaluable in design. If the medium is inhomogeneous then it will generally be impossible to predict the breakdown voltage. Voids in a solid insulator are regions of enhanced field strength and consequently form nuclei for breakdown. The problem facing a manufacturer is to decide whether the microscopic voids present in, for example, a finished cable will lead to breakdown. Previous methods of testing have measured the total energy dissipated in the insulation. Such a technique is not satisfactory since the ultimate breakdown may be probably due to one particular void which until failure contributed only a small fraction of the energy losses.

The AC discharge detector registers the effect of each void. A high-voltage 50 c/s alternating current is applied to the cable. At different points in the voltage cycle different sized voids break down, since the void size determines the breakdown voltage. Each time an individual breakdown occurs there is corresponding change in voltage that takes place in about 10^{-8} sec. Such a pulse will give rise to a radiated wave containing a band of frequencies up to 100 Mc/s. Thus an amplifier and suitable detector will enable the display of each void failure. In practice only the components at 500 kc/s are observed—this procedure enables the effect of interfering signals to be minimised. The test waveform is displayed on a cathode-ray tube and appears as an ellipse. Once round the ellipse corresponds to one cycle of the waveform. When the applied voltage is increased in intensity the voids start to breakdown and spikes occur, on the ellipse, which correspond to the 500 kc/s components of the energy radiated on breakdown.

A pulse generated in the equipment is also displayed on the ellipse and, being adjustable, is used to determine the magnitude of the breakdown pulses. In general the largest spike is measured and the applied voltage left on for 24 hours. The size of the largest spike is then redetermined. If there is an increase in size, the particular void is unstable, and will continue to grow until a breakdown channel occurs right through the insulation. In such a case the portion of cable under test would be rejected. The position of the void is determinable to a certain extent by comparing the behaviour on the negative half-cycle with that on the positive half-cycle. The display enables internal discharges to be distinguished from corona, spurious external disturbances, or contact noise.

The equipment is housed in two steel cases and has a total weight of 130 lb. The extra-high-tension control unit is contained within one case, together with the voltmeter and display oscilloscope. Voltage control is by a 1 kVA continuously variable auto-transformer which feeds the test transformer. The latter is external to the equipment and must be free of noise at the working voltage, or equipped with a suitable noise filter. A good quality transformer is usually noise-free up to one third of its working voltage. The second case contains the amplifier and calibrator unit.

TELEPHONING DATA ECONOMICALLY

The increasingly large amounts of information that are being processed by high-speed electronic techniques require that the material to be processed, and the results obtained, be transmitted with speed between different parts of the country. Speed of transmission is necessary to prevent the accumulation of material at any one particular place. A variety of different machines exists for processing information, and often the speed of operation is so fast as to make communication of results by written letter an uneconomical proposition.

The data subset is a device produced by Bell Telephone Laboratories, New York, that can transmit information at a rate of about 1,000 words per minute over commercial telephone lines. Such a speed is about 10 times that of conventional teletypewriter systems. The device may be used as a link between computers at different ends of the country—allowing completely automatic operation—or may be used by a secretary as an alternative to sending letters. The input to the subset would be designed for a particular application. For a computer it could be made to accept the computer code; for a secretary it could be made to operate an electric typewriter. Other applications are possible. Apart from the input circuit the device needs no modification for each one.

The standard input circuit is a magnetic tape which contains the information to be transmitted in serial form. The information is in the form of a code in which each character is represented by a group of pulses. On the tape the pulses appear as a series of magnetic spots. As the tape is run through the machine the magnetic spots give rise to voltage pulses which are in turn used to switch a tone of 1,200 c.p.s. on and off. The tone pulses are transmitted over a telephone line and decoded by a second data subset. An error detection device is incorporated which is able to detect errors and initiate a repeat of the erroneous passage.

The data subset uses a band of frequencies from about 700 to 1,700 c.p.s. and employs an odd-parity check code. Each symbol to be transmitted is represented by a combination of either three pulses and four spaces or five pulses and two spaces. The receiving subset adds up the number of pulses in each character and if the answer comes to neither three nor five it recognises that an error has been introduced and sends a "repeat" signal. The present prototype model is the size of an office typewriter, but production models will be much smaller. No vacuum tubes are used in the circuits, all operations being performed by transistors, diodes and ferroelectric crystals.

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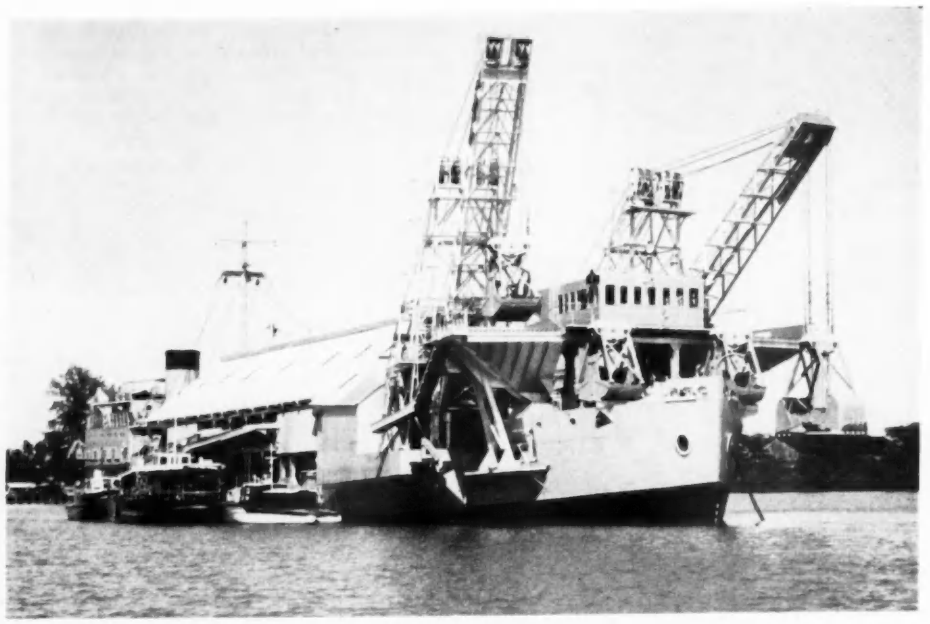
FROM TANKER TO DEEP-SEA DREDGE

The peculiar looking craft shown in the illustration was once an oil tanker; conversion has changed her into a grab dredge which her owners, Aokam Tin Limited, will use for gaining tin ores from the sea bed off the west coast of Thailand. The conversion, which took two years to complete, has been done under the supervision of Priestman Brothers, Hull, England, while the vessel, the "Pibul," was laid up on moorings in the Prai River, near Butterworth, Province Wellesley, Malaya.

The operators of the two units are stationed in the pilot house, one at each side of the vessel, and through the side windows they have a full view of the work and are able to control the units with efficiency and little effort. The winch mechanism for each dredging unit consists of a Ward Leonard motor generator set controlling two hoisting and holding motors which drive the winch mechanism.

Once the material has left the grab it passes through grizzley bars into feed hoppers whence it is removed by means of a plate-type feeder, one of which is located at each side of the vessel. The feeders deliver the material on to a central elevating conveyor which raises it into the mouth of a revolving screen. From the screen the material is discharged into a purpose-made distribution box which leads it into jigs along both sides of the vessel. After a final cleaning and washing process the tin ore is bagged on board the vessel and stored prior to dispatch.



The "Pibul" was a tanker. Radical conversion has made her into a grab dredge for tin mining in the open sea off the west coast of Thailand.

The total installed horse-power on board the dredge is now 3,200 and the total weight of machinery and structural steelwork, including the "factory roof," which was added in order to convert to the dredge, was approximately 1,100 tons; this replaced 450 tons removed from the vessel during the conversion.

The original Diesel-driven twin-screw machinery has been removed and in its place there have been fitted three Diesel alternators which will provide power throughout the vessel for all purposes. Twin-screw alternating-current propulsion motors have also been installed in the same compartment together with the associated distribution boards, control gear, resistance units and other auxiliary equipment.

Two Priestman deep grabber units have been rigged forward on a false-deck structure which, as may be seen from the illustration, overhangs the sides of the vessel. These two units, which are of the level-luffing type, will each handle a 4 cub. yd. Priestman heavyweight grab of the four-rope type at depths down to 220 ft. below water level. The total load of grab and contents will be 15 tons and a hoisting speed of 400 ft. per minute will be obtained. The maximum outreach is 40 ft. and the minimum for discharging purposes 20 ft. At 100 ft. depth below water level it is expected that the intake by each dredging unit will be in the region of 200 cub. yd. per hour.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
Film Evening. Central London Branch. White Hall Hotel, Bloomsbury-square, W.C.1. Wed., May 8, 7.30 p.m.

BIRMINGHAM
Film Evening. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Wed., May 8, 7.15 p.m.

BRISTOL
"Presentation Lighting," by C. R. Passmore. Bristol and West of England Branch. Grand Hotel, Bristol. Fri., May 10, 8 p.m.

HALIFAX
"Developments in Fluorescent Lighting," by J. W. Bessant. Halifax Branch. Crown Hotel, Horton-street, Halifax. Wed., May 8, 7.30 p.m.

LEEDS
Discussion on "Synchronous Electric Clocks." Leeds Branch. Great Northern Hotel, Leeds. Mon., May 6, 7.30 p.m.

NEWCASTLE-UPON-TYNE
"The Nightstor Story," by E. H. Parker. Tyneside Branch. Crown Hotel, Newcastle-upon-Tyne. Tues., May 7, 7.30 p.m.

READING
Annual General Meeting. Oxford, Reading and Districts Branch. Palmer Hall, West-street, Reading. Tues., May 7, 7.15 p.m.

STOKE
"Earth Loop Testing," by E. H. Lea. Stoke and Crewe Branch. Grand Hotel, Hanley, Stoke. Fri., May 10, 7.30 p.m.

Building Centre

LONDON
Films on "The Control and Eradication of Dry Rot," exhibited by Protim Ltd. Wed., May 8, 12.45 p.m.
Films on "Tubes of all Trades," exhibited by Stewarts and Lloyds Ltd. Wed., May 15, 12.45 p.m.

Chemical Engineering Group

LONDON
"Some New Chemical and Physical Aspects of Polyester Resin Technology," by L. H. Vaughan. Joint Meeting with the Plastics and Polymer Group. The Society of Chemical Industry, 14 Belgrave-square, S.W.1. Tues., May 14, 5.30 p.m.

Chemical Society

LONDON
Centenary Lecture on "Structural Evidence Regarding the Solid Addition-Compounds of Ethers and Amines with Halogens and Other Molecules Acting as Electron Acceptors," by Professor Dr. O. Hassel. Thurs., May 9, 7.30 p.m.

BIRMINGHAM
Repetition of Centenary Lecture, as above. Birmingham Branch. Chemistry Department, The University, Birmingham. Fri., May 10, 4.30 p.m.

DUBLIN
"Organic Semi-Conductors," by Professor D. D. Eley. Irish Republic Branch. University Chemical Laboratory, Trinity College, Dublin. Fri., May 10, 7.45 p.m.

DURHAM
"Chemical Evolution," by Professor J. D. Bernal. Newcastle and Durham Branch. University Science Laboratories, South-road, Durham. Mon., May 13, 5.15 p.m.

EXETER
"Reduction by Metal-Ammonia Solutions," by Professor A. J. Birch. Exeter Branch. Washington Singer Laboratories, Prince of Wales-road, Exeter. Fri., May 17, 5 p.m.

Engineers' Guild

EDINBURGH
Luncheon Meeting. Speaker: A. M. Dunnett, Editor of *The Scotsman*. Edinburgh Centre. Scottish Liberal Club, 109 Princes-street, Edinburgh. Mon., May 13, 12.30 for 12.45 p.m.

LEEDS
Luncheon Meeting. "The Need for More Professional Engineers," by Dr. J. Pearson. Yorkshire Branch. Mansion Hotel, Roundhay Park, Leeds. Mon, May 6, 12.45 for 1 p.m.

Faraday Society

BRISTOL
Bourke Lecture on "Electrokinetic Researches," by Professor A. J. Rutgers (University of Ghent). Chemistry Department, The University, Bristol. Wed., May 8, 5.30 p.m.*

NEWCASTLE-UPON-TYNE
Repetition of the Bourke Lecture, as above. Chemistry Department, King's College, Newcastle-upon-Tyne. Fri., May 10, 5 p.m.*

READING
Repetition of the Bourke Lecture, as above. Chemistry Department, The University, Reading. Thurs., May 9, 4.30 p.m.*

Illuminating Engineering Society

LONDON
Annual General Meeting, at 5.30 p.m. "Changing Tastes in Design," by Paul Reilly, at 6.30 p.m. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., May 14.

LIVERPOOL
Annual General Meeting. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Tues., May 14, 6 p.m.

Incorporated Plant Engineers

LONDON
"Contemporary Plant Engineering in the United States," by H. M. Sylvester. London Branch. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., May 7, 7 p.m.*
GLASGOW
"Developments in Boiler Feedwater Treatment," by J. S. Couper. Glasgow Branch. Scottish Building Centre, 425-427 Sauchiehall-street, Glasgow. Thurs., May 9, 7.15 p.m.
LIVERPOOL
"Nuclear Reactors for Power Generation," by J. A. Dixon. Merseyside and North Wales Branch. Exchange Hotel, Liverpool. Thurs., May 9, 7.15 p.m.
MANCHESTER
"High-Pressure Hydraulic Pumps and Their Associated Control Valves," by A. M. Worswick. Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., May 14, 7.15 p.m.
ROCHESTER
"Safety and the Factories Act," by V. B. Jones. Kent Branch. King's Head Hotel, High-street, Rochester. Wed., May 15, 7 p.m.

Institute of Physics

LIVERPOOL
Annual General Meeting. "Rocket Exploration of the Upper Atmosphere," by Professor H. S. W. Massey. Liverpool and North Wales Branch. Department of Electrical Engineering, The University, Liverpool. Fri., May 10, 6.30 p.m.*

Institute of Road Transport Engineers

CARDIFF
"Service Methods and Construction of Commercial Vehicles," by C. H. Rowley. South Wales Group. South Wales Institute of Engineers, Park-place, Cardiff. Fri., May 10, 7 p.m.

Institution of Civil Engineers

LONDON
"Water Supply for Doha, Qatar," by Charles Hogg and G. M. Swan. Public Health Division. Tues., May 7, 5.30 p.m.*
James Forrest Lecture on "Large Telescopes," by Dr. R. v.d. R. Woolley. Tues., May 14, 5.30 p.m.*
BIRMINGHAM
Annual General Meeting and Film Evening. Midlands Association. James Watt Memorial Institute, Great Charles-street, Birmingham. Thurs., May 9, 6 p.m.
BRISTOL
Annual General Meeting. South Western Association. New Engineering School, University-walk, Bristol, 8. Thurs., May 16, 6 p.m.
NEWCASTLE-UPON-TYNE
Graduates' and Students' Annual General Meeting. Northern Counties Association. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Tues., May 7, 6.15 p.m.
Association Annual General Meeting. Northern Counties Association. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Tues., May 14, 6.15 p.m.

Institution of Electrical Engineers

LONDON
Discussion on "The Co-ordination of Education and Practical Training in Sandwich Courses," opened by C. Grad and A. Draper. Education Discussion Circle. Mon., May 6, 6 p.m.*
"Invention and Nature," by F. W. Meredith. Measurement and Control Section. Tues., May 7, 5.30 p.m.*
"The World's Copper Resources," by H. J. Miller. Utilization Section. Thurs., May 9, 5.30 p.m.*
Discussion on "A Survey of Transistor Circuit Techniques." Radio and Telecommunication Section. Wed., May 15, 5.30 p.m.*
BIRMINGHAM
Discussion on "The Influence of Maintenance Requirements on the Design of Industrial Electrical Equipment," opened by H. C. Fox and J. H. Harris. South Midland Centre. James Watt Memorial Institute, Great Charles-street, Birmingham. Mon., May 6, 6 p.m.*
LEEDS
Annual General Meeting. North Midland Centre. Offices of the Yorkshire Electricity Division, 1 Whitehall-road, Leeds. Tues., May 7, 6.30 p.m.
MANCHESTER
Annual General Meeting. "Lighting for the Amateur Stage," by F. Day. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., Mar. 7, 6.15 p.m.*

Institution of Locomotive Engineers

DONCASTER
"Locomotive Feedwater Treatment," by J. S. Hancock and A. J. Parsons. North Eastern Centre. Danum Hotel, Doncaster. Thurs., May 23, 6.45 p.m.

Institution of Mechanical Engineers

LONDON
James Clayton Lecture on "Projection Planetarium and Shell Construction," by Professor Walther Bauersfeld. Fri., May 10, 6 p.m.*
LONDON (*continued*)
Annual General Meeting. "Modern Marine Propulsion," by A. R. Hopwood and R. S. Saunders. London Graduates' Section. Tues., May 14, 6.30 p.m.*
"Diesel Engine Lubricants: Their Selection and Utilisation, with Particular Reference to Oil Alkalinity," by A. Dyson, L. J. Richards and K. R. Williams. Meeting in conjunction with the Lubrication and Internal Combustion Engine Groups. Fri., May 17, 6 p.m.*
COVENTRY
Repetition of James Clayton Lecture on "Mechanical Breathing Machines," by Captain G. T. Smith-Clarke. Midland Branch. St. Mary's Hall, Coventry. Thurs., May 16, 6.30 p.m.

Institution of Mining and Metallurgy

LONDON
Annual General Meeting, at 4 p.m., open only to corporate and non-corporate members of the Institution. Induction of G. Keith Allen as President and other business, at 5.15 p.m. Geological Society's apartments, Burlington House, Piccadilly, W.1. Thurs., May 16. (Tea at 4.30 p.m.)

Institution of Production Engineers

WOLVERHAMPTON
"Gas Turbines: Basic Principles and Production Difficulties," by C. E. Wurr. Wolverhampton Graduate Section. Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton. Wed., May 15, 7.30 p.m.

Royal Aeronautical Society

LONDON
First Lanchester Memorial Lecture, by Dr. Theodore von Kármán. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., May 9, 6 p.m.*
"Reinforced Plastics for Primary Aircraft Structures," by W. A. Baker. Tues., May 14, 7 p.m.

Royal Institution

LONDON
"Orreries and Planetariums," by Professor Sir Harold Spencer Jones. Fri., May 10, 9 p.m.

Royal Meteorological Society

LONDON
Discussion on "Analysis of Geophysical Time Series," opened by J. M. Craddock, H. Charnock and Dr. S. Rushton. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., May 15, 5.15 p.m.*

Royal Society

LONDON
"Chemical Research at the Atomic Energy Research Establishment," by Dr. R. Spence. Thurs., May 9, 4.30 p.m.*

Royal Society of Arts

LONDON
"The St. Lawrence River Power Project," by Dr. Otto Holden. Thurs., May. 9, 5.15 p.m.*
Trueman Wood Lecture on "Science in Archaeology," by Sir Mortimer Wheeler. Wed., May 15, 2.30 p.m.

Royal Statistical Society

LONDON
Discussion on "Analysis of Geophysical Time Series." Joint Meeting with the Royal Meteorological Society, as above. Wed., May 15, 5.15 p.m.*
Discussion on "Some Problems of Statistical Inference," opened by Professor G. A. Barnard, Professor M. G. Kendall and Dr. B. L. Welch. Study Section. E.L.M.A. Lighting Service Bureau, 2 Savoy-hill, W.C.2. Wed., May 8, 6.15 p.m.

Society of Chemical Industry

LONDON
Annual General Meeting. Chairman's Address on "A Pilgrim's Progress from Corrosion," by T. H. Turner. Corrosion Group. Tues., May 7, 6.30 p.m.
Annual General Meeting. Corrosion Group's Education Panel. Wed., May 8, 11 a.m.

Society of Engineers

LONDON
"Meteorology To-Day," by Sir Graham Sutton. Geological Society's Apartments, Burlington House, Piccadilly, W.1. Mon., May 6, 5.30 p.m.*

Society of Industrial Radiology

LONDON
"Investment Castings and Their Inspection," by A. Tomkinson. British Institute of Radiology, 32 Welbeck-street, W.1. Fri., May 24, 7 p.m.

Society of Instrument Technology

MANCHESTER
Annual General Meeting. "Industrial Application of Radio Isotopes," by H. A. Tapsfield. Manchester Section. College of Technology, Manchester. Tues., May 14, 7.30 p.m.
NEWCASTLE-UPON-TYNE
Annual General Meeting. Newcastle Section. King's College, Newcastle-upon-Tyne. Wed., May 15, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

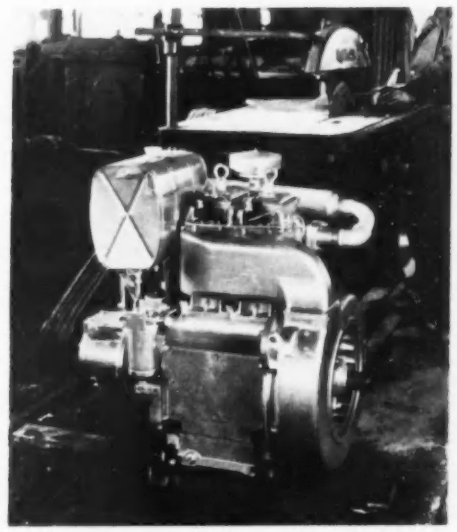
* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Engineering Group, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Engineers' Guild, 78 Buckingham-gate, London, S.W.1. (ABBey 7315.)
Faraday Society, 6 Gray's Inn-square, London, W.C.1. (CHAncery 8101.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (SLOane 9806.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Locomotive Engineers, 28 Victoria-stret, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. (LANgham 3802.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Society of Chemical Industry, 14 Belgrave-square, London, S.W.1. (BELgravia 3681.)
Society of Engineers, 17 Victoria-street, London, S.W.1. (ABBey 7244.)
Society of Industrial Radiology, 2 Tomswood-terrace, Barkingside, Essex. (HAInault 5488.)
Society of Instrument Technology, 20 Queen Anne-street, London, W.1. (LANgham 4251.)

AIR-COOLED DIESELS

Power Range: 4 to 12·5 b.h.p.

Another manufacturer to introduce a range of small air-cooled Diesel engines is Ruston and Hornsby, Limited, Lincoln. The new engines comprise the YBA range, manufactured in one and two-cylinder sizes, giving a power range from 4 to 12·5 b.h.p. They are basically similar to the water-cooled series which has been in use in industrial plant for some years. Prototype models have been tried in contractors' plant, and have operated satisfactorily under all weather conditions. On all-purpose carrier duties, a 1 YBA averaged a fuel consumption of 0·18 gallons per hour over 700 hours operation. This model running at 1,800 r.p.m. will produce 6¼ b.h.p. on the 12 hour rating. Maximum



The YBA range of air-cooled Diesel engines is for light industrial use.

torque occurs at approximately 1,100 r.p.m. and is then about 21·5 lb.-ft. under the rated conditions. The 2 YBA engines develop 12½ h.p. at 1,800 r.p.m., and again with a maximum torque occurring at about 1,100 r.p.m.

The fan housing is integrally cast with the flywheel housing and the fan is of the conventional multi-vane type bolted to the flywheel. The volute ducting can easily be removed for inspection purposes. A centrifugal high-speed governor driven from the camshaft is arranged directly in line with the fuel-pump rack. Drives may be taken from either end of the engine, either at full or half speed (on the camshaft). The engines are directly interchangeable with the water-cooled YB series, and no modifications to the fixing arrangements are needed. They operate on the four-stroke cycle with open-type piston chambers and direct injection.

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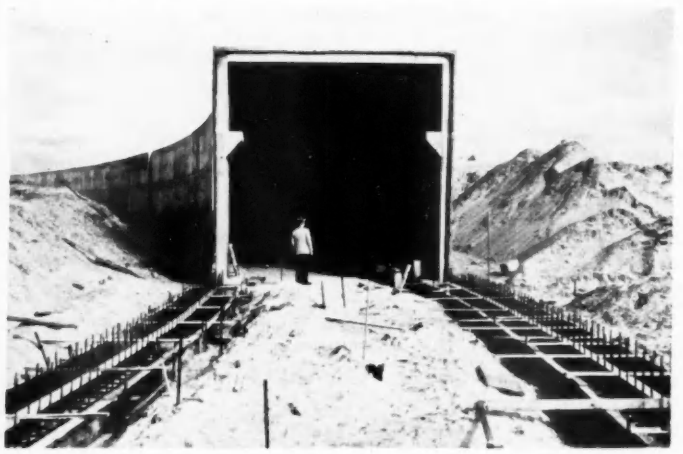
PRINTED CIRCUITS WITHOUT ETCHING

A technique for the production of printed circuits without the use of etching or plating has been developed by the Rogers Corporation, Hartford, Connecticut. The basis of the process is a phenolic-impregnated cellulose sheet material which can be cured and formed into three dimensional shapes. Several processes have been developed for producing circuits. One is the die-stamping process in which continuous copper strip is punched into the board. The copper is adhesive-backed, and the board itself forms the cutting edge and female die. Excess copper is stripped away, before the application of standard compression-moulding techniques, and salvaged as scrap. Terminal boards and switches may also be made in this manner.

ATOMIC REVIEW

Double Double

ALCHEMISTS, witches and modern scientists have one thing in common—the conviction that by creating an unusual situation or environment, the uncommon event can be made to occur. Thus the sorcerer, muttering incantations based on no known vocabulary, would mix in a potion rare herbs and noxious fluids in the hope that such an unnatural combination would yield some marvel; the scientist sets out to achieve a similar result by assembling an elaborate confection of copper wires and glass bottles. There is of course a difference. Whereas the occult experiment tends to be somewhat random in its technique, the physicist knows roughly what to expect. He can also define with considerable accuracy the artificial situation he wishes to create. Among what are potentially the most fruitful conditions available to the modern physicist are those in which atomic fragments (protons or electrons) are accelerated to very high velocities in complex machines designed for that purpose. The extent to which marvels can be expected depends largely on the final kinetic energy produced and on the number of energetic particles reaching the target per unit time, that is on the beam intensity. In usefulness these two characteristics may be regarded as rivals above energies of about 300 MeV: although to double the beam current may not produce exactly the same effect as doubling the particle velocity, both tend to increase the number of nuclear reactions which occur. A number of machines designed for this purpose are described below. Work at Harwell on particle accelerators was discussed in Atomic Review last week.



(Left) The size of the alternating gradient proton synchrotron to be built at the Brookhaven National Laboratory may be gathered from this view of the site excavation. The rectangular building in the foreground houses the 3·2½GeV cosmotron.

(Below) A section of tunnel for the Brookhaven synchrotron, which will give proton energies of 25 to 30 GeV.

Accelerators

Alternating Gradient Synchrotron

An alternating gradient synchrotron (AGS) is being built at the Brookhaven National Laboratory. It is expected that the machine will accelerate protons up to energies of 25,000 MeV and deliver a pulse of 10^{9} particles every 3 seconds. It is hoped that the number of protons per pulse will eventually be stepped up by a factor of 100.

The machine employs a new method of magnetic focusing, called strong focusing, which makes it possible to keep the beam of particles on course with a deviation of less than 0·002 in. in 100 ft. The beam actually travels some 175,000 miles. A steel and copper hoop, 842 ft. in diameter, will be housed in a subterranean tunnel of concrete 17 ft. 8 in. in height and 18 ft. in width. Part of the tunnel will include a building that contains the target. The particles will be initially accelerated to 50 MeV in a linear accelerator and injected into the synchrotron. The particles are then accelerated around the half-mile long vacuum chamber, being kept in their orbit by means of 240 electromagnets. The acceleration will be accomplished by means of 12 radio-frequency accelerating stations. The machine is expected to be in operation in 1960.

1,000 GeV

At a meeting of the American Nuclear Society last year a design was outlined for an accelerator capable of producing particle energies in the region of 10^{12}eV.

Double Synchrotron

A conventional accelerator would have to resort to beam energies of 540,000 MeV in order to produce a 30,000 MeV collision between a proton and a fixed target. A new type of machine that can produce collisions of this magnitude with beam energies of 15,000 MeV is to be constructed for the Midwestern Universities Research Association, in which 15 major universities participate. The machine consists of two fixed-field alternating-gradient synchrotrons interconnected so that the two proton beams meet in head-on collision. The installation has the shape of a figure 8 and is 1,000 ft. long by 500 ft. wide. The fixed-field system permits the use of magnets driven from a non-pulsing generator and so considerably reduces the complexity of the power supplies required. At present the machine is not far past the rough sketch stage, but small scale models are testing the principles involved. Soon a 10 ton model will be built to provide the second stage for the tests.

Hilac

The chief method of making artificial elements heavier than uranium is to bombard heavy nuclei with alpha particles accelerated in a cyclotron. However, it is desirable to accelerate heavier particles than helium nuclei, and to this end a new type of accelerator, the heavy ion accelerator (Hilac), is being constructed in the radiation laboratory at Berkeley. The machine, now nearing completion, will accelerate nuclei as heavy as argon, which has an atomic weight of 40. It is hoped that elements up to number 105 will be eventually produced with the help of the new machine.

Soviet Synchrotron

A proton synchrotron capable of accelerating protons to energies of 10,000 MeV is in operation at the Joint Nuclear Research Institute established by the Soviet Union. The particles are accelerated in a vacuum chamber situated between the pole pieces of a toroidal magnet. The magnet consists of four quadrants with a mean radius of 28 metres separated by air gaps of 8 metres. One of the gaps is occupied by the injector, two others by the accelerating electrodes, and the fourth is used to extract the particles.

Protons are first accelerated in a linear accelerator to energies of between 8·5 and 9 MeV and then focused, as they travel along a path of 10 metres, by means of a magnet system. An electrostatic deflector is used to align the beam which is then deflected through 75 deg. by a further magnet and introduced into the synchrotron chamber. The vacuum chamber has an aperture of 200 cm. by 36 cm., and its total length is 204 metres. After acceleration the beam can either be deflected on to targets situated near the straight sections or into a special target room.

For the particles under acceleration to remain in the correct orbit, variations in the magnetic field and the accelerating frequency must be synchronised. It has been calculated that if the relative error in frequency is 0·1 per cent., the radial displacement of the particle can be up to 6 cm. In the electromagnet system itself, each of the four quadrants consists of twelve 750 ton blocks. The external diameter of the magnet is 72 metres and the total weight, including the windings, is 36,000 tons.

The volume of the vacuum chamber is 160 cu. m. and a vacuum of 10^{-6} mm. of mercury is necessary. The presence of large alternating magnetic fields precluded the use of large metallic

elements in the design of the chamber. To overcome this difficulty stainless-steel walls 0·15 cm. thick are used for the vertical members in the area penetrated by the flux. The sheets are divided into insulated sections of such a size that the distortion of the magnetic field by eddy currents is tolerable. The horizontal walls of the inner chamber are attached directly to the pole pieces. The inner chamber is surrounded by a second chamber at a vacuum of about 1 mm. of mercury. The outer chamber is evacuated by 56 oil vapour pumps. The high vacuum system is fitted with liquid-nitrogen traps which are filled from a central supply system.

Radio-frequency power is obtained from an oscillator using negative feedback through a precision frequency detector. The frequency range of the instrument is 0·15 to 1·5 mc/s. In a test lasting more than 100 hours, the modulation characteristics of the oscillator were found to be stable to better than $\pm$ 7 parts in 10^4. The frequency modulated output of the master oscillator is amplified to 20 kV, using a multi-cascade band-pass amplifier with a power of up to 200 kW. For the measurement of the magnetic fields, a nuclear magnetic resonance method was developed with an accuracy of 1 part in 10^4.

3 GeV Synchrotron

A 3 GeV synchroton is to be built for the James Forrestal Research Centre. The machine will produce heavy mesons in much larger quantities than has hitherto been possible. About the same size and energy as the 3 GeV Cosmotron at Brookhaven, it will produce 50 times the proton current now available. The machine is now reaching the final planning stage after two years of basic design work. The machine is to be financed by the U.S. Atomic Energy Commission and used under the joint administration of Princeton and Pennsylvania Universities.

Synchrotron Output Increased

The synchrotron at the California Institute of Technology has recently been modified. It now operates with an output of 1,200 MeV as compared with 500 MeV when it was first installed in 1951.

Linear Accelerators

A 4 MeV linear accelerator has been constructed by Mullard Limited, Torrington Place, London, W.C.1. It is of the travelling-wave type employing radio-frequency power feedback by means of a rat-race waveguide bridge. The accelerator proper is a metre of corrugated waveguide comprising a short bunching section and a main accelerating section. The radio-frequency generator is a magnetron having a peak pulse power output of 2 MW, and a mean power rating of 2 kW.

Electron output energy can be varied to suit individual requirements by adjustment of the dimensions of the corrugated guide. The electron beam has a diameter of 1 cm. at the output, but if required, this can be focused by an external alternating-gradient type of lens to give a beam diameter of 2 mm. By the insertion of a target at the output, X-rays may be obtained at rates of up to 700 roentgens per minute.

Two linear accelerators in which the beam of a pulsed klystron goes directly into the accelerator guide are produced by the Applied Radiation Corporation, Wallnut Creek, California. Mark 1 is designed for an output of 4 kW at 6 MeV. The beam is delivered in 10 microsecond pulses at 200 milliamperes. Repetition rates vary from manual single-pulse operation to 360 pulses per second. An average beam current of 0·7 milliampere is possible giving an X-ray intensity of 7,000 roentgens per minute at 1 metre.

A proposed model would be designed for energies up to 25 MeV and powers of 60 kW or more. The pulse length would be 40 microseconds and current during the pulse would be 200 milliampere, giving an average current of 3 milliamperes.

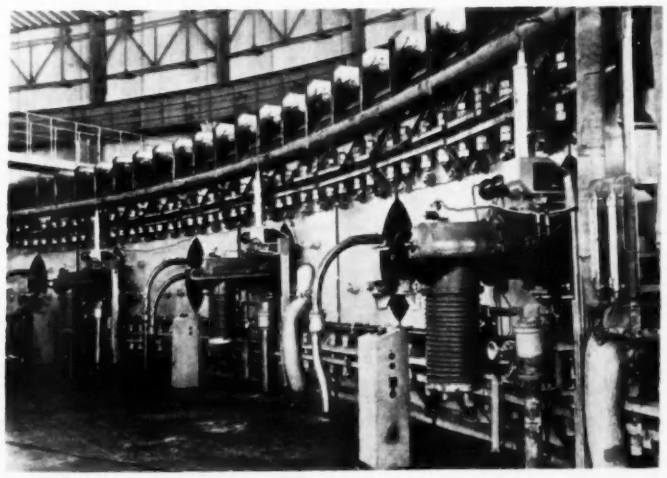
An electron linear accelerator, type V-4800, is being developed by Varian Associates, Palo Alto, California, for use both as a research tool and as a processing machine. It will deliver a 4 kW 500 microampere electron beam at 8 MeV and will produce energies of up to 12 MeV at reduced beam current. Pulse rate is adjustable between 3 and 360 pulses per second and pulse length is usually 5 microseconds. The beam, which originates from an electron gun, attains an energy of 150 keV before it is bunched by a klystron type of cavity and passed through two further accelerator sections. The first of these sections has variably spaced accelerator discs and acceleration is provided to between 4 and 6 MeV. Output beam energy is varied by adjusting the phase and amplitude relations between the radio-frequency power in the first and second sections. The power is provided by a klystron operating at a wavelength of 10·5 cm.

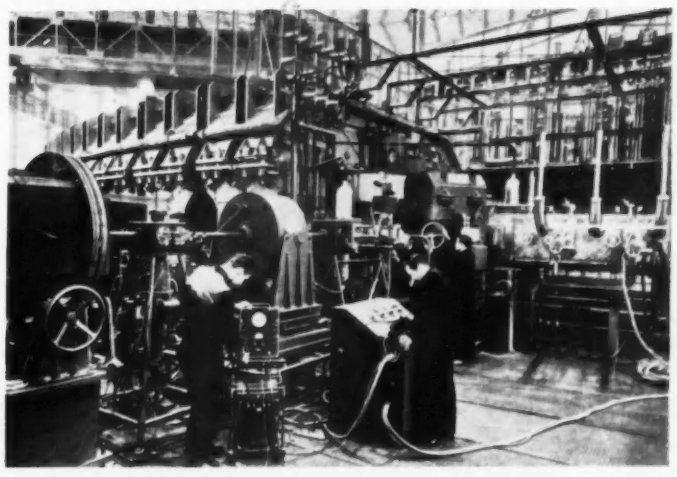
Two types of linear accelerator are manufactured by the High Voltage Engineering Corporation, Cambridge 38, Massachusetts. For the range 2·5 to 7 MeV the type LD-5 is used, for the range 6 to 14 MeV the type LD-10 is used. An LD-5 is at present undergoing final testing before going into operation in a sterilising plant. Each of the machines has a pulsed electron gun, klystron and acceleration tube, and both are water cooled.

Making Accelerators

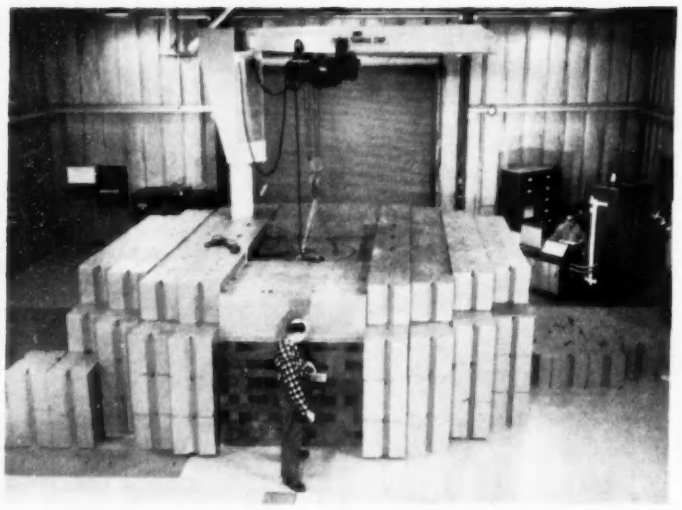
What is said to be the world's largest facility for building and testing radiation apparatus is now in operation at Burlington, Massachusetts. The plant, which occupies an area of 88,000 sq. ft., and cost nearly 2 million dols., has been erected by the High Voltage Engineering Corporation, formerly of Cambridge, Massachusetts, for the manufacture of Van de Graaff and linear particle accelerators. In the heavily shielded test vaults, it is possible to test 16 accelerators simultaneously. At the new facility one of the company's Van de Graaff machines is available for use by industry in pilot studies of electron sterilisation, polymerisation, cross-linking and other radiation processing applications. Since 1947, the company has built over 150 accelerators of different kinds.

The building in which the new Soviet 10 GeV proton synchrotron is housed. It is operated by the Electrophysical Laboratory of the U.S.S.R. Academy of Sciences.

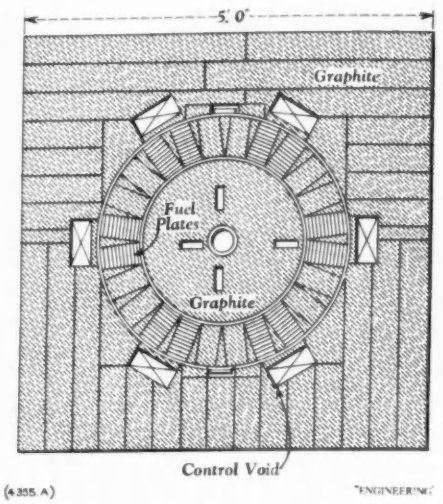




(Left) Part of the electromagnet of the Soviet 10 GeV proton synchrotron, showing a number of vacuum pumps. The toroidal magnet, which comprises four quadrants with 8 metre air gaps, weighs 36,000 tons and is 60 metres in diameter. (Right) Ancillary equipment.



(Left) Checking the activity level of a stringer (string of subjects for irradiation) withdrawn from the thermal column of the training reactor Argonaut at the Argonne National Laboratory.



(Right) Configuration of the Argonaut reactor. The core, containing 20 per cent. enriched uranium, graphite and water, is annular in shape with internal and external graphite reflectors.

Neutrons from Linear Accelerator

It has been announced that a 2 MeV linear accelerator has been used by the Aircraft Nuclear Propulsion Department of the General Electric Company, Cincinnati, Ohio, to provide a thermal neutron flux. With a beam current of 250 microamperes a flux of 10^7 per sq. cm. per second was produced.

A water-cooled gold target was used as an X-ray source and a second target of beryllium modified by paraffin provided neutrons by the $Be^9(\gamma,n)\,Be^8$ reaction. The flux produced is considerably lower than that from nuclear reactors, but higher than that obtainable from portable sources. The flux obtained is sufficient to produce useful quantities of radioisotopes that are too short-lived to be transported over any appreciable distance.

American Notes

Lithium

The American Lithium Institute, Incorporated, has been set up to conduct research on the light metal and its compounds. Offices and library will be maintained at Princeton, New Jersey. Research projects will be assigned to colleges and research institutions.

Materials under Radiation

The changes caused by nuclear radiations in materials used in nuclear power plants will be one of the symposium topics to be discussed at the Sixtieth Annual Meeting of the American Society for Testing Materials at Chalfonte Haddon Hall, Atlantic City, New Jersey, from June 16 to 21, 1957. Further information may be obtained from the Society at 1916 Race-street, Philadelphia 3, Pennsylvania.

Nuclear Research Centre

Plans for the construction of a nuclear research centre in Sterling Forest, New York, U.S.A., have recently been announced by the Union Carbide and Carbon Corporation. The major facilities on the site will include: a 5 MW pool-type nuclear reactor with an average neutron flux of 3×10^{13} per sq. cm. per second, a radioactive materials laboratory, an ores and engineering laboratory, and a building for allied research operations and administrative functions. The research centre will be operated jointly by Union Carbide Nuclear Company and Union Carbide Ore Company, two of the Corporation's Divisions. It will serve as the focal point for nuclear research activity within Union Carbide. Research programmes will be geared to the study of the effects of radiation on products and processes involving plastics, gases, metals, carbon, and chemicals. The reactor is a modified version of the Bulk Shield Testing Facility originated by Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Argonaut Training Reactor Critical

The low-power reactor Argonaut, designed and built at Argonne National Laboratory, went critical for the first time on February 9. Argonaut is intended as a university training reactor and this first model will go to the Laboratory's School of Nuclear Science and Engineering. Similar reactors may, however, soon be available commercially, as two United States firms, Daystrom Nuclear Division and American Radiator and Standard Sanitary Corporation, have applied for permits to manufacture and sell units based on the same design. Views of the Argonaut reactor and a diagram showing its configuration appear on this page.

Argonaut is a thermal, heterogeneous, water cooled reactor moderated by graphite and light water. It has an annular core (36 in. outside diameter, 24 in. inside diameter, 24 in. high), and is reflected both internally and externally by graphite. The core contains 204 fuel plates (approximately 24 by 3 by 0·1 in.), assembled in 12 clusters of 17 plates per cluster. The plates contain 20 per cent. enriched-uranium oxide (U_3O_8) dispersed in an aluminium matrix; a total of 3·7 kg. uranium (20 per cent. enriched) is required for criticality. Moderation is provided by graphite segments between clusters and water between the fuel plates (90 gallons water and 476 lb. graphite). The reactor can operate at powers up to 10 kW with thermal neutron fluxes up to about 10^{11} neutrons per sq. cm. per second. Cooling is by natural convection at low power and by forced circulation (up to 6·5 gallons per minute) at higher power levels. The overall size of the rector including shielding is approximately 17 ft. across the flats of the rough hexagon by 7 ft. high.

View of the Argonaut reactor with interior and outer shield plugs removed. There are 204 fuel plates arranged in 12 clusters of 17; one cluster is seen being examined. Graphite and water serve as moderators.

Particular attention has been paid to safety in this reputedly " student-proof " reactor, and two independent systems are provided for emergency shutdown. A dump line empties the coolant-moderator into the dump tank, and, simultaneously, a nitrogen producing system introduces bubbles to reduce the density of the moderator. Artificial bubble formation may also be used to simulate boiling. Cadmium control and safety rods are used for normal reactor operation and shutdown. Experimental facilities available include the usual experimental ports, a graphite thermal column and a shield testing facility. In addition, the internal, cylindrical graphite reflector can be removed and replaced by a portion of a lattice assembly for internal exponential experiments.

Estimated cost of the Argonaut, including building, is quoted as 100,000 dols. Commercial models will probably be sold at 125,000 to 200,000 dols. depending on the experimental facilities required.

APPR Begins Operation

The Army Package Power Reactor (APPR), a prototype nuclear power plant developed by the United States Atomic Energy Commission for the Department of Defence, has generated electricity during test operations at the United States Army Engineer Center, Fort Belvoir, Virginia, and was formally opened by President Eisenhower last Monday. The plant is undergoing tests by the builders, Alco Products Incorporated of Schenectady, New York, preparatory to an extensive performance run to demonstrate reliability. The reactor achieved criticality for the first time on April 8. Electrical output will be 1,855 kW to be distributed on the Fort Belvoir electrical system. Several previous references have been made to APPR in Atomic Review, most recently last February 8.

General Notes

Package Power at Reduced Cost

Plants based on APPR marketed by Humphreys and Glasgow, Limited, are now expected to produce electricity for 1*d.* to 1½*d.* a unit. When

the agreement between Humphreys and Glasgow and Alco was first announced in January, operating costs of between 1¼*d.* and 2*d.* a unit and capital costs of £200 per kW were quoted. These were based on American costings. The capital cost of a 10 MW plant (sufficient to provide light and heat for a community of 20,000 people) is now put at about £1,500,000 or £150 a kW, enabling power to be produced at the lower figure per unit. The revised estimates are based on European manufacturing costs, and further reductions may prove to be possible when detailed figures are available in about a month.

Company Expands

Daniel Adamson and Company, Limited, have announced plans to build a 30,000 sq. ft. extension to their Dukinfield, Cheshire, engineering works. This will provide additional engineering capacity for the fabrication department, which is increasingly concerned with producing plant for the nuclear energy field. Recently the company announced an agreement with Alco Products Incorporated of America and Humphreys and Glasgow, Limited, of London, to build Alco-designed atomic power stations of between 2 and 20 MW capacity. Representatives of Adamson's have visited America to ascertain the special facilities needed for the manufacture of components for the Alco-type pressurised water reactors and other equipment.

U.K.A.E.A. Contracts

Dr. F. A. Tatford, Chief Purchasing Officer of the United Kingdom Atomic Energy Authority, is being appointed Director of Contracts in succession to Mr. R. A. Browning, O.B.E., who is retiring in the near future. Dr. Tatford's office will be at 1 Richmond-terrace, Whitehall, S.W.1.

Britain at Hanover

When the Hanover Trade Fair opened last Sunday, visitors found one of the most ambitious displays on British atomic energy work yet shown on the Continent. The United Kingdom Atomic Energy Authority has provided material for two stands: one of them devoted to developments in nuclear power and the other to radio-isotopes. Nuclear power exhibits cover an area of 4,000 sq. ft. and will include new models of the Dounreay and Calder Hall projects. The Calder Hall model will show for the first time the complete station with four reactors and four cooling towers. Other models and photographs will show the processes by which the atomic reaction provides heat for conversion by steam processes to electricity and some of the ideas for future types of power stations on which research work is in progress. The Atomic Energy Research Establishment at Harwell has arranged an exhibit dealing entirely with the uses which have been developed for industrial purposes of radioactive isotopes produced at Harwell and Amersham. Production of isotopes from these two centres is now running at over 30,000 consignments a year, of which more than one-third are exported to countries all over the world.

The British atomic power industry is represented on the United Kingdom Nuclear Energy Stand at the Fair through the Nuclear Energy Trade Associations' Conference (N.E.T.A.C.), the membership of which comprises the seven principal engineering Trade Associations concerned with the nuclear power field. Mr. Martin Whitehouse, M.A. B.Sc. (Econ.), A.M.I.E.E., Head of the Technical Division of the British Engineers' Association, and Mr. Robert Kaan, Export Division, British Electrical and Allied Manufacturers' Association, have been appointed to represent N.E.T.A.C. at the Hanover Trade Fair. N.E.T.A.C., as part of its programme to make better known overseas the achievements of British industry in the nuclear energy field, will publish, at the time of the Fair, an illustrated brochure "Britain Leads in this Atomic Age," a German translation of which will be available for distribution from the United Kingdom nuclear energy stand.

In Parliament

UNEMPLOYMENT NOT POSSIBLE

Many interesting economic and industrial subjects were brought to the attention of the House of Commons just prior to the rising for Easter. Among the adjournment debates on April 18, for example, was one initiated by Squadron Leader A. E. Cooper (Conservative) on the need for an inquiry by a Select Committee into labour relations in industry.

He referred to the recent strikes in the engineering and shipbuilding industries as having shocked all thinking people, and asked how it could happen that men in good jobs and with a secure future could deliberately jeopardise that future. How, too, could it happen that the leaders of these great industries should be prepared to see their works brought to a standstill? With 50 million people crowded together in this little island, any slowing down of production, from whatever cause, endangered the livelihood not only of the workpeople directly affected, but of everyone else as well.

It should not be imagined that Britain's industrial difficulties were worse than those of other nations, because they were not. In fact, this country's record was much better than that of any other. Nevertheless, strikes were of greater seriousness to us because our economy was so finely balanced. Given good management and good labour relations, combined with effective Government budgetary and monetary policies, there was no possibility of unemployment in this country in the foreseeable future. With an expanding national economy and expanding world trade, Britain's problem in the future would be to find the labour she needed. No country had a greater need for her people to work together as a team. Such working together, of course, could be done only by mutual co-operation. Compulsion would be of no use.

SHOP STEWARDS IN POWER

No improvement in labour relations would alter the purpose of the mischief makers. It was impossible for Government action to provide any adequate solution for strikes and troubles deliberately fomented by persons whose real objective was the destruction of society. Lord Cameron's report on the Briggs dispute had shown how a small coterie having no desire whatever to secure any sort of good relationship with the management, or the betterment of the men in the works, had as their sole objective the destruction of the Briggs organisation.

In recent years, the term "shop steward" had acquired a connotation which was not altogether desirable. Many of these people up and down the country were honest, decent men who had been elected by their fellow employees as being men capable of genuinely and sincerely looking after their interests. But many were nothing less than a fifth column in British industry.

By education and propaganda, trade unionists must be persuaded to take a greater interest in the affairs of their unions; and to ensure that left-wing extremists were not elected to positions of power where they could carry on their disruptive work. Originally, the position of the shop steward had been to act, not as the liaison between managements and the man on the shop floor, but as the link between the man on the floor and his union. During the war, it became convenient for managements to have close liaison with their workers, and the power of the shop stewards gradually increased.

After the war, shop stewards were not slow to take advantage of their new-found position and the unions themselves were very backward in putting any brake on their power. So, to-day, there had been built up in British industry a shop steward movement which was now exercising a quite intolerable pressure upon industry and which, Squadron Leader Cooper said, he was quite sure responsible trade unions would like to see broken. This problem, however, was one with which the trade-union leaders themselves would have to deal, and was not a matter for action by the Government.

WHEN EMPLOYERS HELP THE UNIONS

Speaking in the same debate, Mr. Ray Mawby (Conservative) pointed out that, although many men employed in the same department might belong to the same union, they might, at the same time, be distributed among as many as ten or twelve different branches. The shop steward, however, was freely elected and not under the jurisdiction of any one branch. He could not report regularly to ten or twelve branches and so, naturally, he reported to none.

Some unions tried to solve this difficulty by organising their branch memberships, not on a geographical basis, but according to the industry concerned. In doing so, the unions had occasionally come up against problems with the employers, because, where branch membership was set up on an industrial basis, it meant that many members could not attend their branch meetings.

In a number of these cases, the employers, realising the difficulty and knowing that the unions were trying to put matters right, had offered the use of a room at the works, or in the canteen, so that branch meetings could be held immediately work ended, whether once a fortnight or once a month. In that way, unionists had greater opportunity to attend their branch meetings than would be the case if the branch were organised on a geographical basis.

As a result, not only could the normal business of the branch be dealt with effectively, but the election of the shop stewards could be proved to be a fair one. The representative knew where his responsibility lay and the branch had a considerable amount of control over him. There was no longer any need for him to join other shop stewards to form a shop stewards' movement.

THE THREE GREAT NEEDS

In reply to the debate, Mr. Robert Carr, the Parliamentary Secretary to the Ministry of Labour and National Service, agreed that many people who believed in and wished for the success of free collective bargaining in industry, were worried about recent developments. It was, obviously, too early to say what lessons could be drawn from the recent disputes, because the Courts of Inquiry investigating them had not yet reported.

The only way to deal with the discontented elements satisfactorily was by promoting greater activity among the rank and file of workers in industry, who objected to the activities of such people as much as anyone. He could see no other way. Since the war, Britain had been trying to do what had never been done before, namely, to achieve at one and the same time a combination of full employment, free collective bargaining as the method of fixing wages, and stability in the value of money. It was comparatively easy to secure any two of these three needs at the same time, but extremely difficult to obtain all of them at once. Britain had succeeded in keeping full employment and collective bargaining, but, it had to be admitted, had not achieved stability in the value of her money.

Some people advocated tackling the problem by legislation, by providing for compulsory secret ballots or other devices, but he believed that such remedies would not be effective in practice because they were superficial. It would be like trying to rub out the spots rather than curing the measles.

There was growing dismay about the apparent inability to escape from the wage-price spiral, in which those employees who had an increase in wages benefited in real wages for a short time only, while the other members of the community were further impoverished. Parliament had the right to expect the leaders of both sides of industry to get busy seeking to correct any defects they could find. The Minister of Labour would give careful consideration to the suggestion for a comprehensive independent inquiry.

THE HUMAN ELEMENT

The Great American Railway

At a time when there is more than a little difference of opinion among the British railway unions about long-term policy and short-term tactics, it may be useful to point out one or two features of the American rail union system. Although to judge by some of the advertisement campaigns put out by the railroads in the United States the only issue of importance over there is the size of the featherbed in running locomotives the management-labour structure has worked tolerably well.

Since 1926 there has been a Railway Labour Executive Association to which all the railroad unions have belonged except the Locomotive "Engineers". The Association exists to keep policy in line among its members. There are now 5,000 agreements on file with the National Mediation Board setting a body of "case law" in working relationships. One of the chief agreements is considered to be on seniority but rates of pay are also more or less standard throughout the industry. On wages there were new agreements negotiated on a national basis in November, 1956, for a three-year period covering non-operating employees with deferred increases coming into operation in November, 1957, and November, 1958, with semi-annual adjustments to meet rises in the cost of living. The principle of the deferred increase has thus become accepted by some of the railroad unions. Retirement benefits have come about as a result of legislation and a health service has been established among several participating unions, and more recently still has been taken over by the railroads. One feature of co-operation between the railroads and the unions is the joint effort to educate the public in the use of rail transport against the competition from road, sea and air.

Taking Education Seriously

Growing emphasis on the need for the maximum utilisation of trained manpower in industry is increasingly reflected in the management structure on the educational side. For some time the connection between research and education has been reflected in the fusion at Metropolitan-Vickers of the directorships of research and education. Two announcements in the last week or so reflect the pre-occupation in industry with education and training.

A group education officer has been appointed by Vickers Limited. He is Mr. C. L. Old, now Principal of the College of Technology at Wolverhampton. His work will be to co-ordinate all educational and training activities within the group. The British Transport Commission has decided to set up a separate division under a director of education and training in the manpower adviser's department at its headquarters. He is Mr. J. E. M. Roberts who entered the service of the L.N.E.R. from Oxford University in 1929. The B.T.C. scheme is in special relation to the railway modernisation programme.

Workers on the Board

A recent talk before members of the British Institute of Management by Mr. E. O. Landau, a director of G. Waddington and Son Limited, dealt with the question of a worker-shareholder on the board. This company has such an arrangement arising out of the growing proportion of the capital held by employees. An undertaking was given some time ago that when that proportion reached a certain level there would be employee representation among the directors. The result has been an employee being elected to the board for a three-year period of office. He is paid a fee and his functions are to represent the workers' point of view although inevitably he must begin to have a general point of view on board matters as time goes on.

These are in a sense pioneer days in worker representation at board level. There are certain attractions in the idea. The person elected, if of the right sort, can be a useful director and also do a major job in management-labour relations. A great deal depends on the kind of person elected and on the state of human relations in the organisation at the time when the idea is introduced. It would be easy for the idea to go wrong. For instance, it is not desirable if the director is going to take his own sectional view to the exclusion of all others. Nevertheless, the idea is worth widespread consideration for the contribution it might make to solving the complex problem of human relations in industry.

Negotiation By-Products

You can get a lot of things in this world if you ask for them. One of the most fruitful places for making off with bargains may yet prove to be the wage negotiation table when jaded employers have come to terms on major wages issues. Then may be the time to ask for just a little bit more on the side in the form of a concession which does not seem to raise any great issue of principle.

This may account for the odd assortment of concessions (big in themselves) which the New York State Labor Department has brought together in its latest bulletin. These cover such agreements as the following. One company of bakers allows workers two dozen free rolls a day. Another union has negotiated with a brewery for unlimited amounts of free beer at certain times in the day. A painters' union has negotiated a paid holiday and a 5 dollars present on a worker's birthday. The greetings telegram from the boss presumably will be raised on a subsequent occasion. Quarantine pay for men kept from work by infectious diseases among their children has been fixed by other unions. Some men have pay during jury service.

These by-products, if such they may be called, to the more serious business of getting higher wages for union members, have a growing significance. They are a forewarning that the time is not far distant when trade unionists may be forced to give increasing attention to getting amenities for members rather than bread and butter concessions such as higher pay. If the time should come shortly when workers want more leisure rather than more pay more time may be taken up with these sort of negotiations.

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This year's annual conference of the National Union of Teachers met at Margate. The presidential address of Mr. John Archbold covered among a variety of topics the need to extend the facilities for technical education. This played an important part in his plan for implementing the unfulfilled sections of the 1944 Education Act over a ten-year period.

It was apparent, however, that the members present, like all delegates or members at such conferences, were mainly concerned with the level of remuneration. Conferences are, after all, one means of organising and rationalising the impression which is an almost basic instinct of the human species that one is inevitably under-paid for the work one does. The teaching profession has always suffered from the illusion that remuneration has got something to do with intellectual attainment and little to do with scarce ability, whereas the reverse is true.

At the moment, however, this confusion is hidden by the fact that teachers are scarce—which was not so true when public prejudices about teachers' pay were crystallised into salary scales many years ago and which now haunt teachers in this age of inflation. Teachers are on a good wicket because it is apparent that this country cannot have the 1944 Education Act and its larger supply of technicians on the cheap. We need more and better teachers and he will be a Solomon indeed who can conjure them up without raising salary scales in the process.

Officers for Re-Settlement

The contraction of the armed forces planned over the next five years will lead to the enforced retirement of between 5,000 and 7,000 officers. Among them will be many of field rank between the ages of 35 to 50 who have no knowledge of civilian occupations. There is therefore a major problem of re-settlement, which involves the provision of training facilities.

The Officers' Association, whose principal concern is the welfare of ex-officers, are now considering a number of proposals to provide guidance for those who know their careers will be cut short. Advice panels may be set up in collaboration with the Ministry of Labour in each major town. They would consist of representatives of industry, chambers of trade and trade associations. The service departments will be asked to allow officers to attend "industrial appreciation" and commercial courses which are provided at technical colleges in London, Woolwich, Portsmouth and Leeds and to take advantage of practical training which the Association hope industrialists will offer. Already many firms take officers as trainees and give them opportunities to study various types of work and to choose the field for specialised study which appeals to them most. It is hoped that the number of such public-spirited firms will increase now that the need is greater and more urgent.

To many, both ex-officers and ex-soldiers, the dismemberment of the units in which they have served will be a sad occasion. Even those which remain will have a very different look. Radical change and the up-rooting of tradition is rarely pleasant and for those whose careers are broken up in the process it can be most painful. The Officers' Association are right, therefore, when they ask the service departments to give as much notice as possible to the men concerned and every facility to become acquainted early with the new life that must be theirs.

A Tradition of Tea

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Tea and coffee both figure prominently in a history just published of one of the oldest companies in the country, Twinings of the Strand. R. Twining and Company, Limited, was started 250 years ago when Thomas Twining became, in 1706, Master of Tom's Coffee House, Devereux-court, Strand. The romantic and stimulating story of the firm is told by one of the family, Stephen Twining, who is one of "The reigning generations, Seven and Eight" in Sir Alan Herbert's opening poem to the book.

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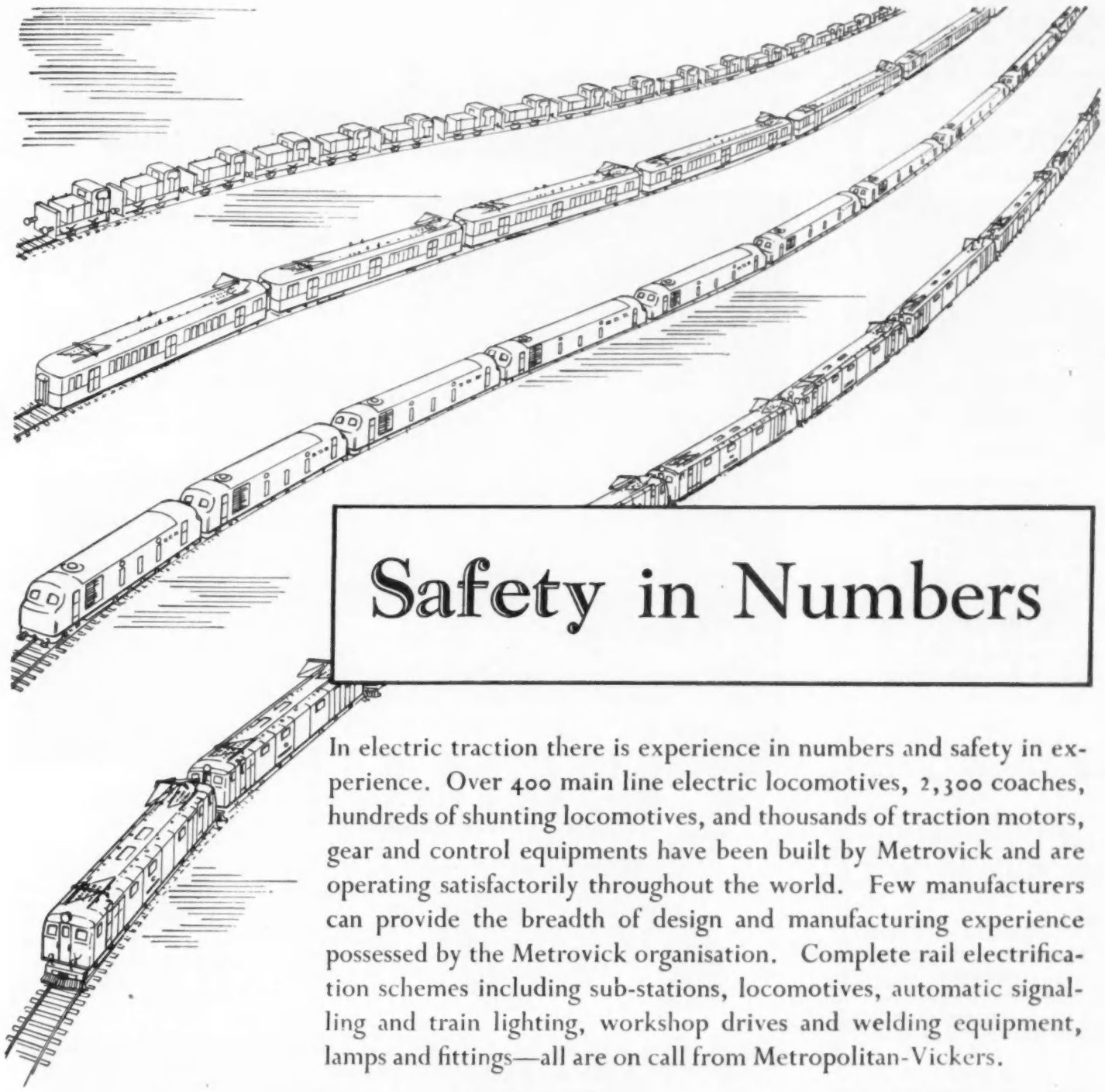

Safety in Numbers

In electric traction there is experience in numbers and safety in experience. Over 400 main line electric locomotives, 2,300 coaches, hundreds of shunting locomotives, and thousands of traction motors, gear and control equipments have been built by Metrovick and are operating satisfactorily throughout the world. Few manufacturers can provide the breadth of design and manufacturing experience possessed by the Metrovick organisation. Complete rail electrification schemes including sub-stations, locomotives, automatic signalling and train lighting, workshop drives and welding equipment, lamps and fittings—all are on call from Metropolitan-Vickers.

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